CALFED WATER QUALITY

WATER QUALITY AFFECTED ENVIRONMENT
DRAFT STATUS DOCUMENT
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CALFED
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Draft Outline (5/30/97)
Water Quality Affected Environment Technical Report

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2.0 INTRODUCTION

The purpose of this report is to describe the affected environment associated with water quality in the San Francisco Bay/Sacramento-San Joaquin Delta (Delta) region in support of the continuing CALFED Bay-Delta Program (CALFED) planning efforts and environmental documentation process. This is one in a series of preliminary reports that will be used with other information to develop the affected environment portion of the pending CALFED Programmatic Environmental Impact Report/Environmental Impact Statement (EIR/EIS).

2.1 Study Area

The geographical focus of this report is the Delta region, which has been identified as the primary "problem area" by CALFED, consisting of the legally defined Delta, Suisun Bay to Carquinez Strait, and Suisun Marsh. **[2]** It is understood that some species (e.g., anadramous fish) that inhabit the Delta are impacted by conditions outside the Delta. Also areas outside the Delta are sources of water quality problems affected the Delta, its inhabitant species, and users of Delta water. In resolving the water quality problems of the Delta, CALFED may undertake actions thoughout its geographic solution area, as necessary. **[1]** The CALFED problem and solution areas can be seen in Figure 2. .[*To be inserted*] This document is consistent with the goals of CALFED, the California Environmental Quality Act (CEQA), and the National Environmental Policy Act (NEPA) and reflects a level of detail appropriate for a programmatic approach to environmental review. **[2]**

2.2 Structure of Report

The Water Quality Affected Environment Report describes the regulatory structure governing Delta water quality, historical Delta water quality conditions including the sources and loadings of pollutants, existing programs that may impact water quality in the Delta, existing water quality in the Delta, the Sacramento River Basin Region, the San Joaquin River Basin Region, the Bay Region, and SWP and CVP service areas outside Central Valley, and historical and existing conditions for the principal parameters of concern. [*To be improved]*

3.0 SOURCES OF INFORMATION [*This section to be checked and cross-referenced*]

3.1 Agency Water Quality Sampling Programs in the Delta

State and federal agencies conduct ongoing water quality sampling programs in the Delta (California Department of Water Resources 1993). The following sections review previous and ongoing studies that would provide data on key water quality variables for CALFED alternatives impact assessment.**[2]**

3.1.1.Interagency Ecological Program of the Sacramento-San Joaquin Estuary.

The Interagency Ecological Program (IEP) was initiated by DWR, the California Department of Fish and Game (DFG), the U.S. Bureau of Reclamation (Reclamation), and the U.S. Fish and Wildlife Service (USFWS) to provide information about the effects of CVP and SWP exports on fish and wildlife in the Bay-Delta estuary. Analysis of water quality components focused on salinity and algal productivity (nutrient) effects. SWRCB, the U.S. Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (Corps), and the U.S. Geological Survey (USGS) currently provide additional program assistance. IEP investigations have changed periodically as new information is gathered and resource topics decrease or increase in importance. Program data are available to the public, annual IEP reports are issued, and newsletters and annual meetings provide information about study results.**[2]**

3.1.2 Municipal Water Quality Investigations Program.

DWR's Municipal Water Quality Investigations (MWQI) Program encompasses the previous Interagency Delta Health Aspects Monitoring Program (IDHAMP) and Delta Island Drainage Investigations (DIDI). IDHAMP was initiated to provide water quality information for judging the suitability of the Delta as a source of drinking water (California Department of Water Resources 1989). Issues of concern included sodium, asbestos, and the potential formation of DBPs. More water quality constituents have been added, including the characterization of Delta inflows and exports, to provide a means of chemically tracking the movement of water through the Delta. The DIDI program started collecting agricultural drainage samples containing pesticide residues, organic materials, and THM precursors in 1985 to evaluate drainage quality among islands with different soil and farming practices (California Department of Water Resources 1990).

SWRCB requires DWR and Reclamation to conduct comprehensive water quality monitoring of the Delta and adjust SWP and CVP operations to satisfy the applicable objectives. Salinity (EC) monitoring stations at Jersey Point and Emmaton are especially important for managing releases at upstream reservoir and export pumping to satisfy water quality objectives. DWR's Delta Operations Water Quality Section prepares and distributes a daily report of data on flows and EC to help in making operational decisions. Figure 3 shows the required monitoring stations located in the Delta. Reclamation also maintains continuous EC recorders at approximately 20 Delta locations.**[2]**

3.1.3 Toxic Substances Monitoring Program

Initiated in 1976, the Toxic Substances Monitoring Program (TSMP) was based on sampling aquatic organisms (e.g., freshwater clams, carp, bass, and trout) in major California water bodies to determine the extent of accumulation of synthetic organic chemicals and heavy metals in tissue (California State Water Resources Control Board 1985). Funding for the TSMP was discontinued in 1996.**[2]**

3.1.4 SWRCB Biennial Reports for Clean Water Act Section 305(b)

SWRCB is required to report on water quality conditions in California streams, lakes, and groundwater basins. The lower San Joaquin River from Vernalis to Stockton has been consistently listed as not fully supporting beneficial uses relating to fisheries because of water quality limitations. In contrast, the Sacramento River has relatively good water quality. Individual Delta channels are not classified in the Section 305(b) reports.[2]

3.1.5 San Francisco Estuary Regional Monitoring Program

The 1993, 1994, and 1995 for Trace Substances annual reports provide information on water quality monitoring data. Specifically, ambient concentration data is available throught the Delta and Bay regions for key parameters of concern.

3.1.6 Sacramento Coordinated Water Quality Monitoring Program Annual Report

Contains ambient concentrations of various water quality parameters of concern. Monitoring stations are located on the Sacramento River. Concentration values are recorded from 1992 to 1995.

3.1.7 U.S. Geological Survey Watstore Data

Much of the available water temperature information came from USGS records, which were obtained from the compact-disk version of U.S. Geological Survey (USGS) WATSTORE database.**[4a]**

3.1.8 Delta Flow and Salinity Measurements

Reclamation and DWR maintained EC monitoring stations at several locations in the Delta during the 1967-1991 water-year period. These measurements were summarized as daily minimum, mean, and maximum values to represent both the average and the daily range of salinity caused by tidal movement at each monitoring location. These data were compiled and summarized as monthly average values.**[4a]**

Historical Delta EC data were integrated with the corresponding Delta hydrologic data to provide an accurate characterization of the effects of CVP Delta operations on estuarine EC conditions. Daily Delta hydrology is already specified in the DAYFLOW data base maintained by DWR. The DAYFLOW records, including daily CVP Delta operations for 1967-1991, were compiled as part of the daily Delta habitat water quality files and summarized as monthly average values.**[4a]**

Ongoing studies and analyses of the Delta region serve as important sources of information for this report. Recent studies and reports include the California Department of Water Resources (DWR) Bulletin 160-93, California Water Plan Update (California Department of Water Resources 1994); documentation for the U.S. Bureau of Reclamation's (Reclamation's) CVP operations (U.S. Bureau of Reclamation 1992); an environmental report prepared by the State

Water Resources Control Board (SWRCB) in support of the 1995 Delta water quality control plan (State Water Resources Control Board 1995); San Francisco Estuary Project (1993) and the estuarine standards proposed in December 1993 by the Environmental Protection Agency (EPA); draft environmental documents for major water resource projects in or adjacent to the Delta, including the Contra Costa Water District's (CCWD's) Los Vaqueros Project (Contra Costa Water District and U.S. Bureau of Reclamation 1993); DWR's North-Delta program (California Department of Water Resources 1990a), and South-Delta program (California Department of Water Resources 1990b); Interim South-Delta Program (California Department of Water Resources 1996a); Los Banos Grandes (California Department of Water Resources 1990c); Draft EIR/EIS for the Delta Wetlands Project (Jones & Stokes Associates 1995); and the Delta Water Transfers Handbook (Authority for Environmental Analysis of Water Transfers 1996). [5]

Additional major sources of data for this report include the DAYFLOW hydrologic database maintained by DWR's Central District and simulation results from the monthly Delta operations planning models known as DWRSIM. DAYFLOW and DWRSIM are described later in the text under "Delta Water Supply Planning"(California Department of Water Resources 1986).[5]

Ongoing studies and analyses of the Bay-Delta serve as important sources of information for this report. Recent studies and reports include California Department of Water Resources (DWR) Bulletin 160-93, California Water Plan Update (California Department of Water Resources 1994a); an environmental report prepared by the California State Water Resources Control Board (SWRCB) in support of the 1995 Delta water quality control plan (California State Water Resources Control Board 1995a); status reports on toxic contaminants in the Delta (California State Water Resources Control Board 1990, San Francisco Estuary Project 1991); draft environmental documents for major water resource projects in or adjacent to the Delta, including DWR's Interim South Delta Program (Entrix, Inc. and Resource Insights 1996); and the EIR/EIS for the Delta Wetlands Project (Jones & Stokes Associates 1995). [2]

DWR and Reclamation operate an extensive network of stations for monitoring Delta salinity conditions. Daily data on EC are used to determine the response of Delta salinity conditions to changes in water supply operations and to demonstrate compliance with applicable water quality standards. EC is a general measure of dissolved salts in water and is the most commonly measured water quality variable in the Delta.[5]

3.2 Water Quality Data Summary

The CALFED Water Quality Data Summary Table provides information on the parameters of concern. For each constituent, the table lists receiving water data, discharge water quality data, time of study, and information source.

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CALFED
WATER QUALITY DATA SUMMARY
General Parameters

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
Alkalinity	X- Greens Landing	X- Vernalis	X- Banks Pumping Plant			X-Natomas East Main Drain			X- Natomas East Main Drain			89-94		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire Environmental Consultants, Inc	1995
Alkalinity		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Dissolved Oxygen	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Dissolved Oxygen	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Dissolved Oxygen	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Dissolved Oxygen	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Dissolved Oxygen		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Dissolved Oxygen		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
Dissolved Oxygen		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92

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	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
Dissolved Oxygen		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
Dissolved Oxygen		X- Laird Park, Airport Way, Hills Ferry,			X- Orestimba Creek, Los Banos Creek, Ingram Hospital, Merced River, Del Puerto Creek, Tuolumne River, Stanislaus River				X- TID 3,5,6 , Spanish Grant Drain		water	91-92		CRWQCB Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from the San Joaquin Basin		Christopher Foe, CRWQCB	Dec-95
Dissolved Oxygen		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93
Dissolved Oxygen		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
Dissolved Oxygen		X				X-AG						88-90	bioassay, drought years	Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from San Joaquin Basin		Central Valley RWQCB	1995
Dissolved Oxygen	X-Greens landing	X- Vernalis	X-Mendola Canal others						drainage	pumping plant sloughs	water	82-91		Appendix C1- Analysis of Delta Inflow and Export Water Quality Data	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95
Dissolved Oxygen			X-Multiple						X		soil	67-91		AppendixC4: Delta drainage water Quality Model	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95
Dissolved Oxygen	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
Dissolved Oxygen	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
DOC/TOC	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96

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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
Hardness	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Hardness	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Hardness	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Hardness		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Hardness						X- 5 locations representing residential, commercial and industrial land uses					water	10/92 -2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Hardness					X- Receiving waters below Sacramento Valley mines						water	86-90		CRWQCB, Central Valley Region Standards, Policies, and Special Studies Unit, Inactive Mine Drainage in the Sacramento Valley, California		Barry Montoya, Xiamang Pan	Jul-92
Hardness					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1994-1995 Monitoring Report		Woodward-Clyde Consultants	Sep-95
Hardness					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
pH	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
pH	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994

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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
pH	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
pH	X- Veterans Bridge, Freeport Marina, River Mile 44										water	1994-1995		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
pH					X-Spring Creek, Keswick Reservoir, Keswick Dam (Sacramento)						water	1979-1980		Evaluation of Lethal Levels, Release Criteria, and Water Quality Objectives for an Acid Mine Waste in *Aquatic Toxicology and Environmental Fate: Eleventh Volume*, ASTM STP 1007, pp. 189-203		Brian J. Finlayson, Dennis C. Wilson	1989
pH		X- Stevenson									water	1987-1988		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
pH		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
pH		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
pH		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
pH						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94

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	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
pH					X- Receiving waters below Sacramento Valley mines					X- Mine Drainage, Shasta Dam	water	86-90	Also list waste rock pH, and acid generating potential	CRWQCB, Central Valley Region Standards, Policies, and Special Studies Unit, Inactive Mine Drainage in the Sacramento Valley, California		Barry Montoya, Xiamang Pan	Jul-92
pH					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
pH		X- Laird Park, Airport Way, Hills Ferry,			X- Orestimba Creek, Los Banos Creek, Ingram Hospital, Merced River, Del Puerto Creek, Tuolumne River, Stanislaus River				X- TID 3,5,6 , Spanish Grant Drain		water	91-92		CRWQCB Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from the San Joaquin Basin		Christopher Foe, CRWQCB	Dec-95
pH		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X-Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93
pH		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X-Multiple					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
pH	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
pH (alkalinity)	X-									mines	water		Effects on fish	Evaluation of Lethal Levels, release Criteria, and Water Quality Objectives for an Acid-Mine Waste		B.J. Finlayson D. C. Wilson	1989
pH	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Temperature	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Temperature	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994

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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
Temperature	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Temperature	X- Veterans Bridge, Freeport Marina, River Mile 44										water	1994-1995		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Temperature		X- Stevenson									water	1987-1988		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Temperature		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
Temperature		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
Temperature		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
Temperature		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93
Temperature		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
Temperature	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996

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	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
Temperature	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via Internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
TOC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
TOC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
TOC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
TOC						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
TOC					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
TOC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93
TOC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
TOC	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996

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WATER QUALITY DATA SUMMARY
General Parameters

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
TOC/DOC	X- Greens Landing	X- Vernalis	X- Banks Pumping Plant			X-Natomas East Main Drain		X- Sacramento Regional Wastewater Effluent	X- Natomas East Main Drain		water	90-93		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire Environmental Consultants, Inc	1995
TOC/DOC	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994	DOC for water; TOC for sediment	1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
TOC/DOC	X	X		X-North, South, Central							water, sediment	1995	DOC for water; TOC for sediment	1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Toxicity	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993	48-hour mollusk embryo development; 96-hr. algal growth	1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Toxicity	X- Rio Vista	X- Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Toxicity	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Toxicity					X-Spring Creek, Keswick Reservoir, Keswick Dam (Sacramento)						water	79-80	Chinook salmon, steelhead trout	Evaluation of Lethal Levels, Release Criteria, and Water Quality Objectives for an Acid Mine Waste in *Aquatic Toxicology and Environmental Fate: Eleventh Volume*, ASTM STP 1007, pp. 189-203		Brian J. Finlayson, Dennis C. Wilson	1989
Toxicity					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95	*Ceriodaphnia*	Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
Toxicity	X		X- Freeport, Clarksburg, Walnut Grove, Isleton, Steamboat Slough		X- Sacramento Basin, San Joaquin Basin	X- Sacramento, Stockton			X- Colusa Basin Drain, TID # 3,5,6		water	86-92	Fathead Minnow, *Ceriodaphnia*, *Selenastrum*, *Neomysis*, Striped Bass Toxicity	Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96

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WATER QUALITY DATA SUMMARY
General Parameters

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
Toxicity		X- Airport Way, Hills Ferry, Laird Park			X- Orestimba Creek, Ingram Hospital, Merced River, Del Puerto Creek, Tuolumne River, Stanislaus River				X- TID 3,5,6, Salt Slough, Spanish Grant Drain		water	91-92	*Ceriodaphnia*	CRWQCB Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from the San Joaquin Basin		Christopher Foe, CRWQCB	Dec-95
Toxicity		X- Airport Way, Hills Ferry			X- Orestimba Creek, Ingram Hospital, Merced River, Del Puerto Creek, Tuolumne River		EC		X- TID 3,5,6, Salt Slough, Spanish Grant Drain		water	91-92		CRWQCB Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from the San Joaquin Basin		Christopher Foe, CRWQCB	Dec-95
TSS	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
TSS	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
TSS	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
TSS	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County	Larry Walker Associates	Feb-96
TSS		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
TSS		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
TSS		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93

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WATER QUALITY DATA SUMMARY
General Parameters

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
TSS						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
TSS					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
TSS		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93
TSS		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
TSS	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Turbidity					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
Turbidity	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Turbidity	X-Greens landing	X- Vernalis	X-Mendola Canal others						drainage	pumping plant sloughs	water	82-91		Appendix C1- Analysis of Delta Inflow and Export Water Quality Data	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95

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WATER QUALITY DATA SUMMARY
Nutrients

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or	Time	Notes	Paper	Prepared	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other	Sediment	of Study			For		
Ammonia	X- Greens Landing		X- Banks Pumping Plant					X- Sacramento Regional Wastewater Treatment Plant			water	83-91		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire Environmental Consultants, Inc	1995
Ammonia	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Ammonia	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Ammonia	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Ammonia		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
Ammonia		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
Ammonia		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
Ammonia						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Ammonia		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93

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WATER QUALITY DATA SUMMARY
Nutrients

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
Ammonia		X- Laird Park, Airport Way, Hills Ferry,			X- Multiple				X- TID 3,5,6 , Spanish Grant Drain	Un-ionized	water	91-92		CRWQCB Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from the San Joaquin Basin		Christopher Foe, CRWQCB	Dec-95
Ammonia		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
Ammonia		X				X-AG						88-90	bioassay, drought years	Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from San Joaquin Basin		Central Valley RWQCB	1995
Ammonia	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database			
Nitrate						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Nitrate/Nitrite	X- Freeport		X- Banks Pumping Plant					X- Sacramento Regional Wastewater Treatment Plant			water	90-93		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire Environmental Consultants, Inc	1995
Nitrate/Nitrite	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Nitrate/Nitrite	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Nitrate/Nitrite, Nitrogen	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993	Total N for sediment	1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993

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WATER QUALITY DATA SUMMARY
Nutrients

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
Nitrate/ Nitrite, Organic N	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database			
Phosphate	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Phosphate	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Phosphate	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Phosphorus						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93	Total, dissolved	Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Total P	X- Freeport		X- Banks Pumping Plant					X- Sacramento Regional Wastewater Treatment Plant			water	89-93		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire Environmental Consultants, Inc	1995
Phosphorus	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
TKN	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database			
TKN						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94

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WATER QUALITY DATA SUMMARY
Salts

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or	Time	Notes	Paper	Prepared	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other	Sediment	of Study			For		
Bromide	X- Greens Landing	X- Vernalis	X- Banks Pumping Plant			X-Natomas East Main Drain			X-Natomas East Main Drain		water	90-94		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire Environmental Consultants, Inc	1995
Bromide	X-Greene's landing	X- Vernalis	X- Mendola Canal others						drainage	pumping plant sloughs	water	82-91		Appendix C1- Analysis of Delta Inflow and Export Water Quality Data	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95
Bromide	X-Greene's landing	X- Vernalis	X- Mendola Canal others						drainage	pumping plant sloughs	water	82-91		Appendix C1- Analysis of Delta Inflow and Export Water Quality Data	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95
Chloride		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Chloride	X-Greene's landing	X- Vernalis	X- Mendola Canal others						drainage	pumping plant sloughs	water	82-91		Appendix C1- Analysis of Delta Inflow and Export Water Quality Data	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95
Chloride	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
EC	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
EC	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
EC	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96

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WATER QUALITY DATA SUMMARY
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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
EC					X-Spring Creek, Keswick Reservoir, Keswick Dam (Sacramento)						water	79-80		Evaluation of Lethal Levels, Release Criteria, and Water Quality Objectives for an Acid Mine Waste in *Aquatic Toxicology and Environmental Fate: Eleventh Volume*, ASTM STP 1007, pp. 189-203		Brian J. Finlayson, Dennis C. Wilson	1989
EC		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
EC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
EC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
EC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
EC						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
EC					X- Receiving waters below Sacramento Valley mines					X- Mine Drainage, Shasta Dam	water	86-90	Also list waste rock pH, and acid generating potential	CRWQCB, Central Valley Region Standards, Policies, and Special Studies Unit, Inactive Mine Drainage in the Sacramento Valley, California		Barry Montoya, Xiamang Pan	Jul-92
EC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93

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WATER QUALITY DATA SUMMARY
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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
EC		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
EC	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
EC	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Salinity	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Salinity	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Salinity	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Salinity (TDS, EC)		X-Vernalis, multiple										85-87	low/high flow, mud and salt sloughs	Sources and Concentrations of Selenium in the San Joaquin River		USGS/Saphen Clifton, Robert Gilliom	1988
Salinity (TDS, EC)		X				X-AG						88-90	bioassay, drought years	Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from San Joaquin Basin		Central Valley RWQCB	1995
Salinity (TDS, EC)	X-Greene's landing	X- Vernalis	X- Mendola Canal others						drainage	pumping plant sloughs	water	82-91		Appendix C1- Analysis of Delta Inflow and Export Water Quality Data	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95
Salinity (TDS, EC)			X-Multiple						X			1955, 86-92		Appendix C2:Analysis of Delta Agricultural Drainage Water Quality Data	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95
Salinity (TDS, EC)			X-Multiple						X		soil	67-91		AppendixC4: Delta drainage water Quality Model	Delta Wetlands Project??	Jones & Stokes Associates??	Sep-95

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WATER QUALITY DATA SUMMARY
Salts

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
TDS		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
TDS						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
TDS	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
TDS/EC	X- Greens Landing	X- Vernalis	X- Banks Pumping Plant			X-Natomas East Main Drain		X- Sacramento Regional Wastewater Treatment Plant	X-Natomas East Main Drain; Sacramento Slough; Colusa Basin Drain		water	89-93		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire [illegible]	1995

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WATER QUALITY DATA SUMMARY
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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other							
Carbofuran		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	3/91-4-91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
Carbofuran		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
Carbofuran		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
Carbofuran	X- above Colusa, Rio Vista, Mallard Island, Greens Landing		X- Barker Slough, Lindsay Slough						X- Drains in Delta, Colusa Basin Drain		water	83-90		Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96
Carbofuran		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93
Carbofuran	X- Colusa Basin	X- Rio Vista	X-Chipps Isl.		X				X			90-92	Figures, at ricefield drainage basin and down stream, over time	Concentrations of Dissolved Rice Pesticides in the Colusa Basin and Sacramento River, California, 1990-92		Kathryn Crepeau, Kathryn Kuivila and Joseph Domalski	90-92
Carbofuran		X				X-AG						88-90	bioassay, drought years	Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from San Joaquin Basin		Central Valley RWQCB	1995
Carbofuran	X	X-Vernalis			x						water	91-94	samples taken near center of flow	Dissolved Pesticide Data for the San Joaquin River at Vernalis and the Sacramento River at Sacramento, CA, 1991-94	USGS 95-110	MacCoy, Crepeau, Kuivila	1995

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WATER QUALITY DATA SUMMARY
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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other							
Carbofuran	multiple					X_runoff			x		water	1994	sites near ag.	Pesticides and Pesticide Degradation in Stormwater Run-off:Sacramento River Basin, CA	American Water Resources Assoc.	J. Domagalski	1996
Carbofuran			Chipps Isl		x						water	56-88	loads, distribution, flow, application and discharge rates	Distribution of Pesticides in the Sacramento=San Joaquin Delta	USGS Yearbook	K.Kuivila	1991
Carbofuran	X-Grimes									Applications	Water	70-88	Lots of info, few tables etc. species Pesticide sensitivity	The Effects of Toxic Contaminants in Water of the San Francisco Bay and Delta	Bay/Delta Oversight Council	H.C. Bally S. Clark J. Davis UC Davis Lan Wiborg AQUA-Science, DWR	1995
Chlordane								X				mostly 95	D. Sources, Ranges, Survey Data	Toxic Organic Constituent Literature Assessment	SFBAPPG/	Larry Walker Associates, Montgomery Watson	1996
Chlordanes	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Chlordanes	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Chlordanes	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
Chlorodane	X	X	X		X	X- Fresno area	X- Fresno area				water, sediment	81-94		Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96
Chlorodane	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			

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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Authors	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other							
Chlorpyrifos	X	X-Stockton/S. Stockton		X	X	X	X					94/95	figures	Chlorpyrifos in Urban Storm Runoff		CRWQCB	1996
Chlorpyrifos				X						Sources-Urban		mostly 95	D. Sources, Ranges, Survey Data	Toxic Organic Constituent Literature Assessment	SFBAPPG	Larry Walker Associates, Montgomery Watson	1996
Chlorpyrifos		X				X-AG						88-90	bioassay, drought years	Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from San Joaquin Basin		Central Valley RWQCB	1995
Chlorpyrifos	Freeport, Colusa, Rio Vista	Vernalis, Modesto	Chipps Isl.,Martinez	X	x							91-92	following rainfall, bioassay	Concentrations, Transport, and Biological Effects of Dormant Spray Pesticides in the SF Estuary, CA		Kathryn Kuivala, Christopher Foe	1994
Chlorpyrifos		Vernalis			x						water	92-93	Dispersion of pesticides following storms	Nonpoint Sources of Pesticides in the San Joaquin River, CA:Input from Winter Storms, 1992 93	USGS/National WQAP	Joseph Domagalski	1995
Chlorpyrifos	X	X-Vernalis			x						water	91-94	samples taken near center of flow	Dissolved Pesticide Data for the San Joaquin River at Vernalis and the Sacramento River at Sacramento, CA, 1991-94	USGS 95-110	MacCoy, Crepeau, Kuivila	1995
Chlorpyrifos	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Chlorpyrifos		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	3/91-4/91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
Chlorpyrifos		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Salt Slough, Mud Slough, Del Puerto Creek, Los Banos Creek, Merced River, Orestimba Creek, Tuolumne River, Stanislaus River, Newman Wasteway					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92

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WATER QUALITY DATA SUMMARY
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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other							
Chlorpyrifos		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Salt Slough, Mud Slough, Del Puerto Creek, Los Banos Creek. Merced River, Orestimba Creek, Tuolumne River, Stanislaus River, Newman Wasteway					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
Chlorpyrifos					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	Apr-00
Chlorpyrifos	X	X							X-San Joaquin Basin		water	93-94		Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96
Chlorpyrifos		X- HWY 165, Fremont Ford, Hills Ferry, West Main, Laird Park, Maze Blvd, Airport Way			X- Orestimba Creek, Los Banos Creek, Ingram Hospital, Merced River, Del Puerto Creek, Tuolumne River, Stanislaus River, Newman Wasteway				X- TID #5 , Salt Slough, Med Slough		water	91-92		CRWQCB Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from the San Joaquin Basin		Christopher Foe, CRWQCB	Dec-95
Chlorpyrifos		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Salt Slough, Mud Slough, Del Puerto Creek, Los Banos Creek. Merced River, Orestimba Creek, Tuolumne River, Stanislaus River, Newman Wasteway					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93
Chlorpyrifos		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Salt Slough, Mud Slough, Del Puerto Creek, Los Banos Creek. Merced River, Orestimba Creek, Tuolumne River, Stanislaus River, Newman Wasteway					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
Chlorpyrifos	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
Chlorpyrifos				X		urban runoff	X						toxicity data , flow, breakdown of use	Diazinon in Urban Areas	RWQCP	Ashli Cooper	Aug-96

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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other							
Chlorpyrifos													Lots of info, few tables etc. species Pesticide sensitivity	The Effects of Toxic Contaminants in Water of the San Francisco Bay and Delta	Bay/Delta Oversight Council	H.C. Baily S. Clark J. Davis UC Davis Lan Wiborg AQUA-Science, DWR	1995
DDT	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
DDT	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
DDT	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
DDT	X	X	X		X	X- Fresno area	X- Fresno area				water, sediment	83-94		Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96
DDT								X				mostly 95	D. Sources, Ranges, Survey Data	Toxic Organic Constituent Literature Assessment	SFBAPPG/	Larry Walker Associates, Montgomery Watson	1996
DDT	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Diazinon	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Diazinon	X	X		X-North, South, Central							water	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995

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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other							
Diazinon	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District, Sacramento County Water Agency, City of Sacramento	Larry Walker Associates	Feb-96
Diazinon		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis			X- Multiple					X- TID #5 (dairy discharge)	water	3/91-4/91		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; March and April 1991		Lisa Ross	Nov-91
Diazinon		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	91-92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1991-2		Lisa Ross	May-92
Diazinon		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Multiple					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Spring 1992		Lisa Ross	Apr-93
Diazinon					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	Apr-00
Diazinon	X	X			X	X- Sacramento, Stockton, Fresno area	X- Patterson, Tracy, Stockton, Sacramento, Fresno area		X- Drains in Delta, San Joaquin Basin		water	81-94		Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96
Diazinon		X- HWY 165, Fremont Ford, Hills Ferry, West Main, Laird Park, Maze Blvd, Airport Way			X- Orestimba Creek, Los Banos Creek, Ingram Hospital, Merced River, Del Puerto Creek, Tuolumne River, Stanislaus River, Newman Wasteway				X- TID #5 , Salt Slough, Med Slough		water	91-92		CRWQCB Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from the San Joaquin Basin		Christopher Foe, CRWQCB	Dec-95
Diazinon		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Salt Slough, Mud Slough, Del Puerto Creek, Los Banos Creek. Merced River, Orestimba Creek, Tuolumne River, Stanislaus River, Newman Wasteway					X- TID #5 (dairy discharge)	water	92		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Summer 1992		Lisa Ross	Sep-93

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WATER QUALITY DATA SUMMARY
Organics

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other							
Diazinon		X- Laird Park, Stevenson, Fremont Ford, Patterson, Hill Ferry, Vernalis, Maze Blvd.			X- Salt Slough, Mud Slough, Del Puerto Creek, Los Banos Creek, Merced River, Orestimba Creek, Tuolumne River, Stanislaus River, Newman Wasteway					X- TID #5 (dairy discharge)	water	92-93		Department of Pesticide Regulation. Memorandum. Preliminary Results of the San Joaquin River Study; Winter 1992-3		Lisa Ross	Sep-93
Diazinon	X	X-Stockton/S. Stockton		X		X						94/95	figures	Chlorpyrifos in Urban Storm Runoff		CRWQCB	1996
Diazinon	X- Multiple Locations	X-Multiple Locations					X	Deep, shallow and ocean water discharge				mostly 95	D. Sources, Ranges, Survey Data	Toxic Organic Constituent Literature Assessment	SFBAPPG/	Larry Walker Associates, Montgomery Watson	1996
Diazinon		X				X-AG						88-90	bioassay, drought years	Insecticide Concentrations and Invertebrate Bioassay Mortality in Agricultural Return Water from San Joaquin Basin		Central Valley RWQCB	1995
Diazinon				X-Multiple				X-URBAN				95-96	POTW	?? Draft		??-Ask Bart	
Diazinon	Freeport, Colusa, Rio Vista	Vernalis, Modesto	Chipps Isl.,Martinez	X	X							91-92	following rainfall, bioassay	Concentrations, Transport, and Biological Effects of Dormant Spray Pesticides in the SF Estuary, CA		Kathryn Kuivala, Christopher Foe	1994
Diazinon	Sacramento, Rio Vista Freeport, Colusa	Vernalis, Modesto	Chipps Isl.,Martinez	x	x						water	93	following rainfall, measurements downstream	Diazinon Concentrations in the Sacramento and San Joaquin Rivers and SF Bay, CA February 1993	USGS-	Kathryn Kuivala	1993
Diazinon		Vernalis			x							92-93	Dispersion of pesticides following storms	Nonpoint Sources of Pesticides in the San Joaquin River, CA:Input from Winter Storms, 1992 93	USGS/National WQAP	Joseph Domagalski	1995
Diazinon	X	X-Vernalis			x						water	91-94	samples taken near center of flow	Dissolved Pesticide Data for the San Joaquin River at Vernalis and the Sacramento River at Sacramento, CA, 1991-94	USGS 95-110	MacCoy, Crepeau, Kuivila	1995
Diazinon	multiple					X-runoff			x		water	1994	sites near ag.	Pesticides and Pesticide Degradation in Stormwater Run-off:Sacramento River Basin, CA	American Water Resources Assoc.	J. Domagalski	1996

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WATER QUALITY DATA SUMMARY
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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other							
Diazinon				Castro Valley	X	X- Urban/Street gutter	X-Run-off					95-96	Seasonal, rainy season, Flow	Characterization of Insecticide Use and Presence in the Castro Valley Creek Watershed	Alameda County Flood Control and Water Conservation District	J. Scanlin	1996?
Diazinon			Chipps Isl		x						water	56-88	loads, distribution, flow, application and discharge rates	Distribution of Pesticides in the Sacramento=San Joaquin Delta	USGS Yearbook	K.Kuivila	1991
Diazinon													Lots of info, few tables etc. species Pesticide sensitivity	The Effects of Toxic Contaminants in Water of the San Francisco Bay and Delta	Bay/Delta Oversight Council	H.C. Baily S. Clark J. Davis UC Davis Lan Wiborg AQUA-Science, DWR	1995
Diazinon				X		urban runoff	X						toxicity data , flow, breakdown of use	Diazinon in Urban Areas	RWQCP	Ashli Cooper	Aug-96
Diazinon	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
Fecal Coliform						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Fecal Streptococcus						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Pathogens	X- Greens Landing		X- Banks Pumping Plant; Delta Mendota Canal							X- Checkpoint 29?	water	92-93		Study of Drinking Water Quality in Delta Tributaries	California Urban Water Agencies	Brown & Caldwell Archibald & Wallberg Consultants Marvin Jung & Associates McGuire Environmental Consultants, Inc	1995

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WATER QUALITY DATA SUMMARY
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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other							
PCBs	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
PCBs	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
PCBs	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1995
PCBs	X	X	X		X						water	83-87		Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96
PCBs	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Total Coliform						X- 5 locations representing residential, commercial and industrial land uses					water	10/92-2/93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Toxaphene	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1993
Toxaphene	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	1994
Toxaphene		X				X- Fresno area	X- Fresno area				water, sediment	81- 85		Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley	California Urban Water Agencies	J. Phyllis Fox, Elaine Archibald	Jul-96

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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks/Rivers	Stormwater	Rain/Fog	POTW	AG	Other							
Toxaphene	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Toxaphene													D. Sources, Ranges, Survey Data	Toxic Organic Constituent Literature Assessment	SFBAPPG	Larry Walker Associates, Montgomery Watson	1996

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WATER QUALITY DATA SUMMARY
Metals

CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
Cadmium	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Cadmium	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Cadmium	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Cadmium	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Cadmium					X-Spring Creek, Keswick Reservoir, Keswick Dam (Sacramento)						water	79-80		Evaluation of Lethal Levels, Release Criteria, and Water Quality Objectives for an Acid Mine Waste in *Aquatic Toxicology and Environmental Fate: Eleventh Volume*, ASTM STP 1007, pp. 189-203		Brian J. Finlayson, Dennis C. Wilson	Jun-05
Cadmium						X- 5 locations representing residential, commercial and industrial land uses					water	10-92/2-93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Cadmium						X- 5 Sacramento Storm Drains			X- Drains in Sacramento Valley	X- NPDES dischargers-industrial self-monitoring data		87		Draft State Report CRWQCB A Mass Loading Assessment Of Major Point And Non-Point Sources Discharging To Surface Waters In The Central Valley, California, 1985		Barry Montoya, Fred Blatt, Gregory Harris	Oct-88
Cadmium					X- Receiving waters below Sacramento Valley mines					X- Mine Drainage, Shasta Dam	water	86-90	Also list waste rock concentrations	CRWQCB, Central Valley Region Standards, Policies, and Special Studies Unit, Inactive Mine Drainage in the Sacramento Valley, California		Barry Montoya, Xiamang Pan	Jul-92
Cadmium					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1994-1995 Monitoring Report		Woodward-Clyde Consultants	Sep-95

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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
Cadmium					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
Cadmium	X-									mines	water		Effects on fish	Evaluation of Lethal Levels, release Criteria, and Water Quality Objectives for an Acid-Mine Waste		B.J. Finlayson D. C. Wilson	1989
Cadmium	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
Cadmium	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Copper	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Copper	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Copper	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Copper	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Copper					X-Spring Creek, Keswick Reservoir, Keswick Dam (Sacramento)						water	79-80		Evaluation of Lethal Levels, Release Criteria, and Water Quality Objectives for an Acid Mine Waste in *Aquatic Toxicology and Environmental Fate: Eleventh Volume*, ASTM STP 1007, pp. 189-203		Brian J. Finlayson, Dennis C. Wilson	Jun-05

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CONSTITUENT	RECEIVING WATER DATA					Discharge Water Quality Data					Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
Copper		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Copper						X- 5 locations representing residential, commercial and industrial land uses					water	10-92/2-93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Copper						X- 5 Sacramento Storm Drains			X- Drains in Sacramento Valley	X- NPDES dischargers- industrial self-monitoring data		87		Draft State Report CRWQCB A Mass Loading Assessment Of Major Point And Non-Point Sources Discharging To Surface Waters In The Central Valley, California, 1985		Barry Montoya, Fred Blatt, Gregory Harris	Oct-88
Copper					X- Receiving waters below Sacramento Valley mines					X- Mine Drainage, Shasta Dam	water	86-90	Also list waste rock concentrations	CRWQCB, Central Valley Region Standards, Policies, and Special Studies Unit, Inactive Mine Drainage in the Sacramento Valley, California		Barry Montoya, Xiamang Pan	Jul-92
Copper					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1994-1995 Monitoring Report		Woodward-Clyde Consultants	Sep-95
Copper					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
Copper	X-									mines	water		Effects on fish	Evaluation of Lethal Levels, release Criteria, and Water Quality Objectives for an Acid-Mine Waste		B.J. Finlayson D. C. Wilson	1989
Copper	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Copper	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
Mercury	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05

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CONSTITUENT	RECEIVING WATER DATA				Discharge Water Quality Data						Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
Mercury	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Mercury	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Mercury	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Mercury		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Mercury						X- 5 locations representing residential, commercial and industrial land uses					water	10-92/2-93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Mercury						X- 5 Sacramento Storm Drains			X- Drains in Sacramento Valley	X- NPDES dischargers-industrial self-monitoring data		87		Draft State Report CRWQCB A Mass Loading Assessment Of Major Point And Non-Point Sources Discharging To Surface Waters In The Central Valley, California, 1985		Barry Montoya, Fred Blatt, Gregory Harris	Oct-88
Mercury					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1994-1995 Monitoring Report		Woodward-Clyde Consultants	Sep-95
Mercury					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
Mercury	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			

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CONSTITUENT	RECEIVING WATER DATA SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Discharge Water Quality Data Creeks	Stormwater	Rain/Fog	POTW	AG	Other	Water or Sediment	Time of Study	Notes	Paper	Prepared For	Author	Date
Mercury	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
Selenium	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Selenium	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Selenium	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Selenium	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Selenium		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Selenium						X- 5 locations representing residential, commercial and industrial land uses					water	10-92/2-93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94
Selenium						X- 5 Sacramento Storm Drains			X- Drains in Sacramento Valley	X- NPDES dischargers-industrial self-monitoring data		87		Draft State Report CRWQCB A Mass Loading Assessment Of Major Point And Non-Point Sources Discharging To Surface Waters In The Central Valley, California, 1985		Barry Montoya, Fred Blatt, Gregory Harris	Oct-88
Selenium					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1994-1995 Monitoring Report		Woodward-Clyde Consultants	Sep-95

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	SACRAMENTO	SAN JOAQUIN	DELTA	SF BAY	Creeks	Stormwater	Rain/Fog	POTW	AG	Other							
Selenium					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
Selenium		X-Veranlis, multiple										1985-87	low/high flow, mud and salt sloughs	Sources and Concentrations of Selenium in the San Joaquin River	USGS	Saphen Clifton, Robert Gilliom	1988
Selenium	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996
Zinc	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1993		1993 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Zinc	X- Freeport, Rio Vista	X-Stockton, Vernalis, Manteca		X-North, South, Central							water, sediment	1994		1994 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Zinc	X	X		X-North, South, Central							water, sediment	1995		1995 Annual Report San Francisco Estuary Regional Monitoring Program for Trace Substances		San Francisco Estuary Institute	Jun-05
Zinc	X- Veterans Bridge, Freeport Marina, River Mile 44										water	94-95		Sacramento Coordinated Water Quality Monitoring Program 1995 Annual Report	Sacramento Regional County Sanitation District Sacramento County Water Agency City of Sacramento	Larry Walker Associates	Feb-96
Zinc					X-Spring Creek, Keswick Reservoir, Keswick Dam (Sacramento)						water	79-80		Evaluation of Lethal Levels, Release Criteria, and Water Quality Objectives for an Acid Mine Waste in *Aquatic Toxicology and Environmental Fate: Eleventh Volume*, ASTM STP 1007, pp. 189-203		Brian J. Finlayson, Dennis C. Wilson	Jun-05
Zinc		X- Stevenson									water	87-88		Water-Quality Data, San Joaquin Valley, California, April 1987 to September 1988		USGS, Regional Aquifer-System Analysis San Joaquin Valley Drainage Program	
Zinc						X- 5 locations representing residential, commercial and industrial land uses					water	10-92/2-93		Municipal Storm Water Discharge Management Program Technical Memorandum Task 3.1 Storm Water Characterization Study	Camp, Dresser & McKee, Inc.	Kinetic Laboratories, Inc.	Jan-94

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Zinc						X- 5 Sacramento Storm Drains			X- Drains in Sacramento Valley	X- NPDES dischargers-industrial self-monitoring data		87		Draft State Report CRWQCB A Mass Loading Assessment Of Major Point And Non-Point Sources Discharging To Surface Waters In The Central Valley, California, 1985		Barry Montoya, Fred Blatt, Gregory Harris	Oct-88
Zinc					X- Receiving waters below Sacramento Valley mines					X- Mine Drainage, Shasta Dam	water	86-90	Also list waste rock concentrations	CRWQCB, Central Valley Region Standards, Policies, and Special Studies Unit, Inactive Mine Drainage in the Sacramento Valley, California		Barry Montoya, Xiamang Pan	Jul-92
Zinc					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1994-1995 Monitoring Report		Woodward-Clyde Consultants	Sep-95
Zinc					X- Rheem Creek (San Pablo Bay), Walnut Creek (Suisun Bay)						water	94-95		Contra Costa Clean Water Program FY 1995-1996 Monitoring Report		Woodward-Clyde Consultants	96
Zinc	X- Multiple	X- Multiple	X	X- San Pablo Bay								75-93	Available via internet www.iep.ca.gov	Interagency Ecological Program for the Sacramento San Joaquin Delta. Water Quality Monitoring Database METAFILE.DOC			
Zinc	X-									mines	water		Effects on fish	Evaluation of Lethal Levels, release Criteria, and Water Quality Objectives for an Acid-Mine Waste		B.J. Finlayson D. C. Wilson	1989
Zinc	X				X						water			Sacramento Coordinated Water Quality Monitoring Program 1995 annual report	Sacramento Regional County Sanitation District Sac. County water Agency City of Sac	Larry Walker Associates	1996

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4.0 REGULATORY ISSUES

4.1 Water Rights

Water use in California is characterized by two basic types of water rights: riparian water rights and appropriative water rights. Riparian water rights are based on ownership of land adjacent to a waterbody while appropriative water rights are unrelated to riparian land ownership and are based on the principle of "first in line, first in right".

Riparian water rights are not lost if unused and are not quantified. Landowners with these rights can divert portions of a waterbody's natural waterflow for reasonable and beneficial use on their land, provided the land is located within the same watershed as the waterbody. During times of water shortage, all riparian water rights holders must share the available supply according to each landowner's reasonable requirements and uses (California State Water Resources Control Board 1989). Appropriative water rights account for the vast majority of water rights in California. These rights are based on the concept that the first to claim and beneficially use a specific amount of water has a superior claim to later appropriators.

Appropriative rights are quantified and may be lost if unused. Appropriative water rights issued after 1914 are under the jurisdiction of the State Water Resources Control Board (SWRCB). All water users existing in 1914 were assigned the same seniority. The SWRCB issues appropriative rights with conditions to protect other water rights holders, including Delta and upstream riparian water users, and to protect the public interest including fish and wildlife resources. The quantity and quality of water used by existing riparian and senior appropriative users must not be impaired by subsequent appropriative water rights. **[5]** (See surface water, groundwater technical reports)

4.2 Water Quality Rules and Regulations

<u>4.2.1Clean Water Act - Section 303(d)</u>
Section 303(d) of the Clean Water Act requires that each state develop a list, known as a 303(d) list, of water bodies that are water quality impaired. The 303(d) list for each state identifies impaired water bodies and sources of impairment such as mine drainage, agricultural drainage, urban and industrial runoff, and municipal and industrial wastewater discharges. In 1996 the State of California identified approximately 90 impaired water bodies in its 303(d) list. CALFED is using this list to make a preliminary assessment of existing environmental water quality problems in California's Central Valley and Bay-Delta.**[1]**

<u>4.2.2 Endangered Species Act</u>
The federal Endangered Species Act (ESA) requires assessment of water-project operations for effects on fish species listed under ESA as threatened or endangered. In February 1993, the National Marine Fisheries Service (NMFS) issued its biological opinion on the effects of SWP and CVP operations on winter-run chinook salmon. In March 1995, the U.S. Fish and Wildlife Service (USFWS) issued a biological opinion on the effects of SWP and CVP operations on delta smelt. The biological opinions establish requirements for SWP and CVP operations that impose

important constraints on Delta water supply management to protect these listed species. These include requirements for Delta inflow, Delta outflow, Delta Cross Channel (DCC) gate closure, QWEST flows (i.e., net negative Delta outflows), and reduced export pumping because of specified incidental "take" limits. ("Take," as defined in ESA, includes harassment of and harm to a species, entrainment, directly and indirectly caused mortality, and actions that adversely modify habitat.)**[5]**

4.2.3 Central Valley Project Improvement Act of 1992

The Central Valley Project Improvement Act (CVPIA) dedicates 800 thousand acre-feet per year (TAF/yr) of water for fish and wildlife recovery and mandates the acquisition of additional water for fish and wildlife purposes. Reclamation implemented interim changes in its Delta operations during 1993 and 1994, as recommended by USFWS, to dedicate the 800 TAF/yr. Long-term changes in CVP operations that may be required to satisfy CVPIA are being evaluated by Reclamation and USFWS, and a programmatic EIS is expected to be published in early 1998.**[5]**

4.2.4 Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) (PL 99-339) was enacted by the United States Congress and signed into law by the President in 1974. Through the SDWA, the federal government gave the United States Environmental Protection Agency (EPA) the authority to set standards for contaminants in drinking water supplies. The SDWA was reauthorized in August 1996. The Amendments were developed to provide more flexibility, more state responsibility, and more cooperative approaches. The law changes the standard setting procedure for drinking water and establishes a State Revolving Loan Fund to help public water systems to improve their facilities and ensure compliance with drinking water regulations.**[3]**

4.2.5 The Delta Protection Act of 1959

The Delta Protection Act of 1959 requires adequate water supplies for multiple uses (i.e., agriculture, industry, urban, and recreation) within the Delta and for export. Since the law was passed, various water quality and flow objectives have been established by SWRCB and the Central Valley Regional Water Quality Control Board (CVRWQCB). These objectives are designed to ensure that the amount and quality of water in the Delta is sufficient to satisfy multiple uses. For example, water quality objectives require limiting Delta water supply operations, particularly the SWP and CVP, that affect the fresh water-salt water balance in the Delta.

4.2.6 Porter-Cologne Act

In 1967 the Porter-Cologne Act established the SWRCB as the State agency with primary authority over the regulation of water quality and allocation of appropriative surface water rights in California. The Porter-Cologne Act is the primary water quality legislation administered by SWRCB and provides the authority to establish water quality control plans (i.e., basin plans) that are reviewed and revised periodically. Nine regional water quality control boards (RWQCBs) implement SWRCB policies and procedures throughout the State. Water quality control plans designate beneficial uses for specific surface water and groundwater resources and establish water quality objectives to protect those uses. Both numerical and narrative water quality objectives are established to protect beneficial uses. Water quality objectives are generally established to protect human health or aquatic life. Once approved by EPA, the objectives become water quality standards that must be implemented under the federal Clean Water Act (CWA). To ensure that water quality objectives are met, SWRCB issues water right permits and RWQCBs issue waste discharge requirements for the major point-source waste dischargers, such as municipal wastewater treatment plants and industrial facilities.[2]

SWRCB recently enacted the Enclosed Bays and Estuary Plan and the Inland Surface Waters Plan that set numeric and narrative criteria for toxic metals and organic compounds. Litigation brought against the plans in 1994 resulted in their revocation, and they are currently under review for readoption in 1997. Criteria promulgated in the plans would apply to all permitted and nonpermitted point-source discharges. SWRCB and RWQCBs also implement sections of the CWA administered by EPA, including the National Pollutant Discharge Elimination System (NPDES) permitting process for point and nonpoint sources of certain waste discharges. [2]

The Delta is under the jurisdiction of the Central Valley RWQCB (Region 5), which implements policies and procedures adopted under several water quality control plans. The most recent basin plan was adopted in 1995 (California Regional Water Quality Control Board 1995). Amendments to the basin plan for the control of agricultural subsurface drainage and lower San Joaquin River water quality objectives are currently being considered for adoption (California Regional Water Quality Control Board 1996a). [2]

4.2.7 D-1485 and the 1978 Water Quality Control Plan

In 1978, SWRCB adopted the Water Quality Control Plan for the Sacramento-San Joaquin Delta and Suisun Marsh (1978 Delta Plan). At the same time, SWRCB adopted water-rights decision D-1485. The D-1485 decision required compliance with water quality objectives in the 1978 Delta Plan which were designed to protect natural resources by maintaining Delta conditions as they occurred before operation of the CVP and SWP. D-1485 also required monitoring and study of Delta aquatic resources. The effect of the D-1485 decision was amendment of Reclamation and DWR permits for operating the CVP and SWP. In the 1980's, legal challenges were brought against D-1485 and the 1978 Delta Plan. In 1986, the State was required to revise its water quality standards in the "Racanelli Decision" (*United States v. State Water Resources Control Board* 182 Cal. App. 3d 82 [1986]). Pursuant to that decision, SWRCB implemented a hearing process, known as the Bay-Delta hearings, to review and amend the 1978 Delta Plan.[5] Following this hearing process, SWRCB issued revised water quality objectives in the 1991 Delta Water Quality Control Plan for Salinity, Temperature, and Dissolved Oxygen (1991 Delta Plan). Subsequently, EPA objected to the level of fish and wildlife protection afforded in the 1991 Delta Plan, and Governor Pete Wilson's 1992 water policy called for SWRCB to develop interim measures to protect fish and wildlife. SWRCB then prepared interim water-right terms and conditions for the 1991 Delta Plan in the draft decision D-1630. Actions taken by the National Marine Fisheries Service (NMFS) and USFWS to protect winter-run chinook salmon and delta smelt, respectively, resulted in the withdrawal of D-1630 during the hearing process. However, several new Delta water management concepts presented in D-1630 have been partially adopted in other actions taken by SWRCB, DWR, Reclamation, fishery protection agencies, and other regulatory agencies.[2]

4.2.8 Suisun Marsh Preservation Agreement

The Suisun Marsh Preservation and Restoration Act of 1979, and an associated agreement between federal and State agencies signed in 1987, were designed to mitigate the effects of CVP and SWP operations and other upstream diversions on water quality in the marsh. The agreement includes specific water quality objectives for salinity in Suisun Marsh channels; however, SWRCB has not yet approved this agreement. A salinity control structure (tidal gate) was completed on Montezuma Slough in 1988. D-1485 also directed Reclamation and DWR to develop a plan to protect Suisun Marsh resources. D-1485 set water salinity standards for Suisun Marsh from October through May to preserve the area as a brackish water tidal marsh and to provide optimum conditions for plant production as food for waterfowl.[5]

4.2.9 Draft D-1630 and the 1991 Water Quality Control Plan

SWRCB issued revised water quality objectives in the 1991 Delta Water Quality Control Plan for Salinity, Temperature, and Dissolved Oxygen (1991 Delta Plan). In 1992, SWRCB proposed new interim water-rights terms and conditions in draft D-1630. Although it was never officially adopted D-1630 identified several alternative Delta water management approaches. Some of these approaches have been partially implemented by a variety of agencies including: SWRCB, DWR, Reclamation, fishery protection agencies, and other regulatory agencies. [5]

4.2 10 Bay-Delta Framework Agreement and Bay-Delta Accord

In June 1994, a Bay-Delta Framework Agreement was signed by the Federal Ecosystem Directorate and the Governor's Water Policy Council of the State of California. The framework established a comprehensive program in the Bay-Delta estuary for coordination and cooperation of environmental protection and water supply. The Principles for Agreement, or Bay-Delta Accord, was signed on December 15, 1994. It addressed three major areas of agreement including: formulation of a new Water Quality Control Plan (WQCP) acceptable to both EPA and SWRCB, coordination of SWP and CVP operations that rapidly respond to environmental conditions in the Delta with an adaptive management approach, and implementation of a long-term management approach integrating objectives for water supply and environmental protection.[5]

4.2.11 1995 Water Quality Control Plan

In March 1994, SWRCB initiated development of new water quality standards and released a draft version on December 15, 1994 with the Bay-Delta Accord. SWRCB subsequently released an environmental report that documented the effects of implementing the plan. The WQCP was adopted in May 1995 (1995 Water Quality Control Plan) and incorporated several elements of EPA, NMFS, and USFWS regulatory objectives for salinity and endangered species protection. The 1995 WQCP objectives are expected to be fully implemented with a new water-rights decision (to replace D-1485) within the next 3 years. The major changes associated with the 1995 WQCP in relation to the 1978 and 1991 WQCPs and associated D-1485 requirements are as follows.[5]

- Water-year classifications are based on the 40-30-30 Sacramento Valley Four-River Index and the 60-20-20 San Joaquin Valley Four-River Index. The outflow requirements from February through June depend on the previous month's Eight-River Index runoff volume. [5]

- Delta outflow requirements are the combination of fixed monthly requirements and estuarine habitat requirements (expressed in terms of "X2", the position of the 2-parts-per-thousand [2-ppt] salinity gradient). Because the X2 requirements in the 1995 WQCP depend on the previous month's Eight-River index runoff, the required outflow must be calculated for each month.[5]

- New electrical conductivity (EC) and pulse-flow objectives were established for the San Joaquin River at Vernalis.[5]

- Combined SWP and CVP Delta exports are limited to a percentage of the Delta river inflow (which does not include rainfall). These percentages are 35% from February through June and 65% for the remainder of the year. Export pumping during the pulse-flow period was limited to an amount equivalent to the pulse flow during half of April and half of May.[5]

4.2.12 National Secondary Drinking Water Regulations

National Secondary Drinking Water Regulations (NSDWR) were established by the EPA in 1979 and 1991. These regulations are advisory in nature and are to be applied as determined by the states. These non-enforceable standards represent "... reasonable goals for drinking water quality. The States may establish higher or lower levels which may be appropriate dependent upon local conditions such as unavailability of alternate source waters or other compelling factors, provided that public health and welfare are not adversely affected (Code of Federal Regulations, 41 CFR 143.3)." Public notification is required if the secondary standard for fluoride of 2.0 mg/l is exceeded.[3]

4.2.13 Trihalomethane Regulations

These regulations apply to all public water systems serving populations greater than 10,000. Large sized utilities were required to begin monitoring for total trihalomethanes (TTHMs) in November 1980. The regulation established an MCL of 100 μg/L for TTHMs in the distribution system. TTHMs include the summation of chloroform, bromodichloromethane, dibromochloromethane, and bromoform concentrations. Because THMs can form after the application of the disinfectant, compliance with the MCL is based on a running annual average of at least four sampling points for each treatment plant with 25 percent of the samples taken at locations within the distribution system representing the maximum residence time of water in the system, and with at least 75 percent of the samples being collected from representative sites in the distribution system (considering number of persons served, sources of water, and treatment methods).[3]

4.2.14 Surface Water Treatment Rule

The Surface Water Treatment Rule (SWTR) was promulgated by the EPA in June 1989 and large utilities were required to be in compliance with the Rule by June 1993. The SWTR was promulgated to control the levels of turbidity, *Giardia lamblia*, viruses, *Legionella*, and heterotrophic plate count bacteria in U.S. drinking waters. These five contaminants were included on the list of 83 contaminants to be regulated by the EPA according to the 1986 SDWA Amendments.**[3]**

The SWTR requires all utilities with a surface water supply or a ground water supply under the influence of a surface water supply, to provide adequate disinfection and under most conditions, to provide filtration. Exemptions from filtration of surface water supplies are provided in rare occasions where the source water supply meets extremely rigid requirements for water quality and the utility possesses control of the watershed. Each utility must also perform a watershed sanitary survey at least every five years, according to California state law. **[3]**

4.2.15 Disinfectants/Disinfection By-products Regulation

For several years, EPA has been developing information in anticipation of establishing a revised THM standard as well as standards for disinfectants and additional DBPs.
On September 15, 1992, EPA published a notice in the *Federal Register* that it intended to form a committee to develop the D/DBP regulation through a negotiated rule-making ("Reg-Neg") process. The D/DBP Rule that was developed by the Reg-Neg committee was published by EPA in the *Federal Register* in July 1994. **What did it say?[3]**

4.2.16 California-Federal Operations Group

The 1994 Bay-Delta Framework Agreement established the California-Federal Operations Group (C-FOG) to coordinate SWP and CVP operations and recommend changes in combined Delta operations that might provide additional fish protection and allow Delta exports with reduced fishery impacts. C-FOG was specifically charged with recommending operational changes based on real-time fish-monitoring results to minimize incidental take and satisfy other requirements of ESA biological opinions. C-FOG was also charged with the exchange of information and the discussion of strategies to implement fish protection measures, satisfy 1995 WQCP water quality objectives, and cooperate with IEP to determine factors affecting Delta habitat and the health of fisheries and to identify appropriate corrective measures for CVP and SWP.**[5]**

4.3 Water Quality Regulation Summary [*This summary to be explained better*]

Table 4.1 summarizes the existing regulatory objectives or standards for the primary CALFED water quality parameters of concern.

WATER QUALITY OBJECTIVES
PARAMETERS OF CONCERN

	Suggested Ranges		
Parameter	**Sacramento River**	**San Joaquin River**	**Delta**
Boron			Water: Agricultural Intakes: **< 0.7 mg/l**
Cadmium	Water: River and Tributaries from above State Hwy 32 bridge at Hamilton City: **0.22 µg/l** [a,c,d] Below Hamilton City: **2.2 µg/l** (4 day average) [a,e] **4.3 µg/l** (1 hour average) [a,e] Sediment: [z] **5.0 ppm** (dry weight)	Water: **2.2 µg/l** (4 day average) [a,e] **4.3 µg/l** (1 hour average) [a,e] Sediment: [z] **5.0 ppm** (dry weight)	Water: East of Antioch Bridge: **2.2 µg/l** (4 day average) [a,e] **4.3 mg/l** (1 hour average) [a,e] West of Antioch Bridge: **1.1 µg/l** (4 day average) [x] **3.9 µg/l** (1 hour average) [x] Sediment: [z] **1.2 ppm** (dry weight)
Copper	Water: River and Tributaries from above State Hwy 32 bridge at Hamilton City: **5.6 µg/l** [a,c,d] Below Hamilton City: **10 µg/l** (no hardness connection) [a,d,f] Sediment: [z] **70.0 ppm** (dry weight)	Water: **9.0 µg/l** (4 day average) [a,e] **13 µg/l** (1 hour average) [a,e] Sediment: [z] **70.0 ppm** (dry weight)	Water: East of Antioch Bridge: **10 µg/l** (no hardness connection) [a,d,f] West of Antioch Bridge: **6.5 µg/l** (4 day average) [x] **9.2 µg/l** (1 hour average) [x] Sediment: [z] **34.0 ppm** (dry weight)

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WATER QUALITY OBJECTIVES
PARAMETERS OF CONCERN

	Suggested Ranges		
Parameter	**Sacramento River**	**San Joaquin River**	**Delta**
Mercury (inorganic)	Water: **0.012 µg/l** (4 day average) [b,e] **2.1 µg/l** (1 hour maximum) [a,e] Sediment: [z] **0.15 ppm** (dry weight) Tissue:[i,y] **0.5 µg/gm** (whole fish, wet weight)	Water: **0.012 µg/l** (4 day average) [b,e] **2.1 µg/l** (1 hour maximum) [a,e] Sediment: [z] **0.15 ppm** (dry weight) Tissue: [i,y] **0.5 µg/gm** (whole fish, wet weight)	Water: East of Antioch Bridge: **0.012 µg/l** (4 day average) [b,e] **2.1 µg/l** (1 hour maximum) [a,e] West of Antioch Bridge: **0.025 µg/l** (4 day average) [x] **2.4 µg/l** (1 hour average) [x] Sediment: [z] **0.15 ppm** (dry weight) Tissue:[i,y] **0.5 µg/gm** (whole fish, wet weight)
Selenium	Water: **20 µg/l** (1 hour maximum) [b,e] **5.0 µg/l** (4 day average) [b,e] Tissue: [aa] **4-12 ppm** (fish, whole body, dry weight) **3-7 ppm** (fish food items, food chain, dry weight)	Water:[j] South of Merced River: **20 µg/l** (1 hour maximum) [b,e] **5.0 µg/l** (4 day average) [b,e] North of Merced River: **12 mg/l** (maximum)[b,e] **5.0 µg/l** (4 day average)[b,e] Tissue: [aa] **4-12 ppm** (fish, whole body, dry weight) **3-7 ppm** (fish food items, food chain, dry weight)	Water: East of Antioch Bridge: **20 µg/l** (1 hour maximum) [b,e] **5.0 µg/l** (4 day average) [b,e] West of Antioch Bridge: **20 µg/l** (1 hour average) [b,e] **5.0 µg/l** (4 day average) [b,e] Tissue: [aa] **4-12 ppm** (fish, whole body, dry weight) **3-7 ppm** (fish food items, food chain, dry weight)

WATER QUALITY OBJECTIVES
PARAMETERS OF CONCERN

	Suggested Ranges		
Parameter	**Sacramento River**	**San Joaquin River**	**Delta**
Zinc	Water: River and Tributaries from above State Hwy 32 bridge at Hamilton City: **16 µg/l** [a,c,d] Below Hamilton City: **100 µg/l** (no hardness connection) [a,d,g] Sediment: [z] **120.0 ppm** (dry weight)	Water: **120 µg/l** (4 day average) [a,e] **120 µg/l** (1 hour average) [a,e] Sediment: [z] **120.0 ppm** (dry weight)	Water: East of Antioch Bridge: **100 µg/l** (no hardness connection) [a,d] West of Antioch Bridge: **106µg/l** (4 day average) [x] **117 µg/l** (1 hour average) [x] Sediment: [z] **150.0 ppm** (dry weight)
Carbofuran	Water:[k] **0.4 µg/l** (daily max. and total pesticide) [h]	Water: **0.4 µg/l** (daily max. and total pesticide) [h]	Water: **0.4 µg/l** (daily max. and total pesticide) [h]
Chlordane	Water: **2.4 µg/l** (instantaneous max.) [e] **0.0043 µg/l** (4 day average, total pesticide) [e] Sediment: [z] **7.1 ppm** (dry weight)	Water: **2.4 µg/l** (instantaneous max.) [e] **0.0043 µg/l** (4 day average, total pesticide) [e] Sediment: [z] **7.1 ppm** (dry weight)	Water: **2.4 µg/l** (instantaneous max.) [e] **0.0043 µg/l** (4 day average, total pesticide) [e] Sediment: [z] **7.1 ppm** (dry weight)
Chlorpyrifos	Water:[m] **0.02 µg/l** (4 day average, total pesticide) [l,g]	Water:[m] **0.02 µg/l** (4 day average,total pesticide) [l,g]	Water:[m] **0.02 µg/l** (4 day average,total pesticide) [l,g]
Diazinon	Water:[n] **0.08 µg/l** (1 hour average,total pesticide)[l] **0.04 µg/l** (4 day average, total pesticide)[l]	Water:[n] **0.08 µg/l** (1 hour average,total pesticide)[l] **0.04 µg/l** (4 day average, total pesticide)[l]	Water:[n] **0.08 µg/l** (1 hour average,total pesticide)[l] **0.04 µg/l** (4 day average, total pesticide)[l]

WATER QUALITY OBJECTIVES
PARAMETERS OF CONCERN

	Suggested Ranges		
Parameter	**Sacramento River**	**San Joaquin River**	**Delta**
DDT	Water: **1.1 µg/l** (instantaneous max., total pesticide) [e] **0.001 µg/l** (4 day average, ,total pesticide) [e] Tissue: [y] **1 µg/l** (whole fish, wet weight)	Water: **1.1 µg/l** (instantaneous max., total pesticide) [e] **0.001 µg/l** (4 day average, ,total pesticide) [e] Tissue: [o,y] **1 µg/l** (whole fish, wet weight)	Water: East of Antioch Bridge: **1.1 µg/l** (instantaneous max., total pesticide) [e] **0.001 µg/l** (4 day average, ,total pesticide) [e] West of Antioch Bridge: **1.1 µg/l** (instantaneous maximum) **0.001 µg/l** (24 hour average) Tissue: [y] **1 µg/l** (whole fish, wet weight)
PCB's	Water: **0.014 µg/l** (4 day average) [e] (each of 7 congeners) Sediment: [z] **50 ppm** (dry weight, total) Tissue: [y] **0.5 µg/l** (whole fish, wet weight, total)	Water: **0.014 µg/l** (4 day average) [e] (each of 7 congeners) Sediment: [z] **50 ppm** (dry weight, total) Tissue: [y] **0.5 µg/l** (whole fish, wet weight, total)	Water: East of Antioch Bridge: **0.014 µg/l** (4 day average) [e] (each of 7 congeners) West of Antioch Bridge: **0.014 µg/l** (24 hour average) Sediment: [z] **50 ppm** (dry weight, total) Tissue: [y] **0.5 µg/l** (whole fish, wet weight, total)

WATER QUALITY OBJECTIVES
PARAMETERS OF CONCERN

	Suggested Ranges		
Parameter	**Sacramento River**	**San Joaquin River**	**Delta**
Toxaphene	Water: **0.73 µg/l** (1 hour average) [e] **0.0002 µg/l** (4 day average) [e] Tissue: [y] **0.1 µg/l** (whole fish, wet weight) (sum of 9 organochlorine insecticides)	Water: **0.73 µg/l** (1 hour average) [e] **0.0002 µg/l** (4 day average) [e] Tissue: [y] **0.1 µg/l** (whole fish, wet weight) (sum of 9 organochlorine insecticides)	Water: East of Antioch Bridge: **0.73 µg/l** (1 hour average) [e] **0.0002 µg/l** (4 day average) [e] West of Antioch Bridge: **0.0002 µg/l** (4 day average) [e] Tissue: [y] **0.1 µg/l** (whole fish, wet weight) (sum of 9 organochlorine insecticides)
pH (Alkalinity as $CaCO_3$)			Water: Agricultural Intakes: **< 1.5 me/l**
Ammonia	Water: **0.08 - 2.5 µg/l** (4 day average) [e,p] **0.58 - 35 µg/l** (1 hour average) [e,p]	Water: **0.08 - 2.5 µg/l** (4 day average) [e,p] **0.58 - 35 µg/l** (1 hour average) [e,p]	Water: East of Antioch Bridge: **0.08 - 2.5 µg/l** (4 day average) [e,p] **0.58 - 35 µg/l** (1 hour average) [e,p] West of Antioch Bridge: **0.025 µg/l** (annual median) **0.16 µg/l** (maximum)
Bromide			Water: Drinking Water Intakes: **50 µg/l** [gg, hh]
TOC			Water: Drinking Water Intakes: **3 mg/l** [gg]

WATER QUALITY OBJECTIVES
PARAMETERS OF CONCERN

	Suggested Ranges		
Parameter	**Sacramento River**	**San Joaquin River**	**Delta**
Chloride			<u>Water:</u> Agricultural Intakes: For surface irrigation: [bb] **SAR: < 3** [cc] For sprinkle irrigation: [dd] **< 3 me/l** Drinking Water Intakes: **250 mg/l** [ii]
Nutrients (Nitrate)			<u>Water:</u> Agricultural Intakes: **< 5.0 mg/l** Drinking Water Intakes: **10 mg/l** [jj]
Salinity (EC_w)	<u>Water:</u>	<u>Water:</u>	<u>Water:</u> East of Antioch Bridge: West of Antioch Bridge: Agricultural Intakes: **< 0.7 dS/m or mmho/cm** [ee]
SAR:EC_w [ff] relationship			<u>Water:</u> Agricultural Intakes: SAR EC_w: **0 - 3 > 0.7** **3 - 6 > 1.2** **6 - 12 > 1.9** **12 - 20 > 2.9** **20 - 40 > 5.0**

WATER QUALITY OBJECTIVES
PARAMETERS OF CONCERN

Parameter	Suggested Ranges Sacramento River	San Joaquin River	Delta
Salinity (TDS)	Water:	Water:	Water: East of Antioch Bridge: West of Antioch Bridge: Agricultural Intakes: **< 450 mg/l** Drinking Water Intakes: **500 mg/l** [ii]
Dissolved Oxygen	Water: Keswick Dam to Hamilton City, June 1 to August 31: **9000 μg/l** [d,q] Below I Street Bridge: **7000 μg/l** [d]	Water: Between Turner Cut and Stockton, September 1 through November 30: **6000 μg/l** [d]	Water: [s] All Delta waters west of Antioch Bridge: **7000 μg/l** (minimum) [d,x] All Delta waters: **5000 μg/l** [d,r]
Pathogens			Water: Drinking Water Intakes: **no MCL standard** [kk]
Temperature	Water: Keswick Dam to Hamilton City: **< 56° F** [d,u] Hamilton City to I Street Bridge: **< 68°F** [d,u] I Street Bridge to Freeport: **< 68°F** [d,v] I Street Bridge to Freeport, January 1 through March 31:**< 66°F** [d,w]	Water: At Vernalis: **< 68°F** [d,v]	Water: West of Antioch Bridge: **< 5°C** increase above for receiving water designated as cold or warm freshwater habitat. [x] Alteration of temperature shall not adversely affect beneficial uses. [x] Agricultural Intakes:

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WATER QUALITY OBJECTIVES
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Suggested Ranges			
Parameter	**Sacramento River**	**San Joaquin River**	**Delta**
Turbidity			Water: West of Antioch Bridge: **No adverse effect or > 10 % change** Drinking Water Intakes: **0.5 or 1.0 NTU** [jj] Agricultural Intakes:
Unknown Toxicity [t]			Water: West of Antioch Bridge: Acute- A median of not less than **90%** survival and a 90 percentile of not less than **70%** survival Chronic - **no chronic toxicity** in ambient waters

[a] dissolved form
[b] total recoverable form
[c] The effects of these concentrations were measured by exposing test organisms to dissolved aqueous solutions of 40 mg/l hardness that had been filtered through a 0.45 micron membrane filter. Where deviations from 40 mg/l of water hardness occur, the objectives, in mg/l shall be determined using the following formulas:
$Cu = e^{(0.905)(\ln \text{hardness})} - 1.612 \times 10^3$
$Zn = e^{(0.830)(\ln \text{hardness})} - 0.289 \times 10^3$
$Cd = e^{(1.160)(\ln \text{hardness})} - 5.777 \times 10^3$
[d] Central Valley Regional Water Quality Control Plan
[e] General EPA 304(a) guideline
[f] Within the next year the State Water Resources Control Board or EPA will promulgate/adopt objectives which are hardness dependent. The adoption language is likely to contain a clause saying that the most stringent objective applies. Sometimes the 10 µg/l objective will be more stringent and at other times the new rule will be more stringent.
[g] Similar to the objectives for copper, we expect the State Water Resources Control Board or EPA to promulgate new objectives within the next year which will be more stringent than current objectives.
[h] The Central Valley Regional Water Quality Control Board expects to adopt an objective for carbofuran within the next year. The objective will probably be very similar to the performance goal.
[i] Water quality limited segments for mercury in fish tissue occur in the Sacramento River and Delta.
[j] Water quality limited segments for selenium in the water column from Salt Slough to Vernalis on the San Joaquin River.

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WATER QUALITY OBJECTIVES
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[k] Lower Sacramento River is a water quality limited segment for carbofuran.
[l] California Department of Fish and Game acute (1 hour) and chronic (4 day) hazard assessment criteria.
[m] Sacramento River, San Joaquin River, and Delta water quality limited segments for chlorpyrifos.
[n] Sacramento River, San Joaquin River, and Delta water quality limited segments for diazinon.
[o] San Joaquin River water quality limited segment for DDT in tissue.
[p] Values are a function of pH, temperature, and designation of water body as cold or warm water beneficial use.
[q] When natural conditions lower dissolved oxygen below this level, the concentrations shall be maintained at or above 95% of saturation.
[r] Except those water bodies which are constructed for special purposes and from which fish have been excluded or where the fishery is not important and a beneficial use.
[s] Southern Delta around Stockton is a water quality limited segment for dissolved oxygen.
[t] Bioassay results or other special studies demonstrate toxicity. Sacramento River, San Joaquin River, and Delta are water quality limited segments for "unknown toxicity".
[u] The temperature shall not be elevated above 56°F in the reach form Keswick Dam to Hamilton City nor above 68°F in the reach from Hamilton City to I Street Bridge during periods when temperature increases will be detrimental to the fishery.
[v] The daily average water temperature shall not be elevated by controllable factors above 68°F from the I Street Bridge to Freeport on the Sacramento River, and at Vernalis on the San Joaquin River between April 1 through June 30 and September 1 through November 30 in all water year types.
[w] The daily average water temperature shall not be elevated by controllable factors above 66°F from the I Street Bridge to Freeport on the Sacramento River between January 1 through March 31.
x San Francisco Regional Water Quality Control Board objectives at 100 mg/l hardness. Formulas for calculating objectives for varying hardness levels are as follows:

$Cd = e^{(0.7852H - 3.490)}$ (4 day average)
$= e^{(1.128H - 3.828)}$ (1 hour average)
$Cu = e^{(0.8545H - 1.465)}$ (4 day average)
$e^{(0.9422H - 1.464)}$ (1 hour average)
$Zn = e^{(0.8473H + 0.7614)}$ (4 day average)
$= e^{(0.8473H + 0.8604)}$ (1 hour average)

[y] National Academy of Sciences (NAS)-National Academy of Engineering 1973
[z] Effect range-low (ERLs) concentrations
[aa] San Luis Drain Reuse, Technical Advisory Committee Selenium ecological risk guidelines
[bb] For surface irrigation, most tree crops and woody plants are sensitive to sodium and chloride, use the values shown. Most annual crops are not sensitive, use the salinity tolerance in Ayers and Westcot or equivalent.
[cc] SAR means sodium adsorption ratio. SAR is sometimes reported by the symbol RNa.
[dd] For overhead sprinkle irrigation, and low humidity (< 30%), sodium and chloride greater than 70 or 100 mg/l, respectively, have resulted in excessive leaf adsorption and crop damage to sensitive crops, see Ayers and Westcot.
[ee] EC_w means electrical conductivity of irrigation water, reported in mmho/cm or dS/m.
[ff] At a given SAR, the infiltration rate increases as salinity EC_w increases. To evaluate a potential permeability problem examine SAR and EC_w together.
[gg] Value arrived at in discussion with California Urban Water Agencies (CUWA)
[hh] Bromide value is predicated on the assumption that the MCL for Bromate will be 5 µg/l.

[ii] U.S. EPA Secondary MCL. 1995.

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[jj] U.S. EPA Current MCL. 1995.
[kk] U.S. EPA requires removal of 99.9 % of Giardia and 99.99% of viruses during water treatment.

5.0 HISTORICAL CONDITIONS

5.1 Sources and Loadings of Parameters of Concern
5.2 Existing Programs to Address Parameters

This section has all of the information available but it has not yet been cut and pasted. Following are the load tables that will be contained in this section.

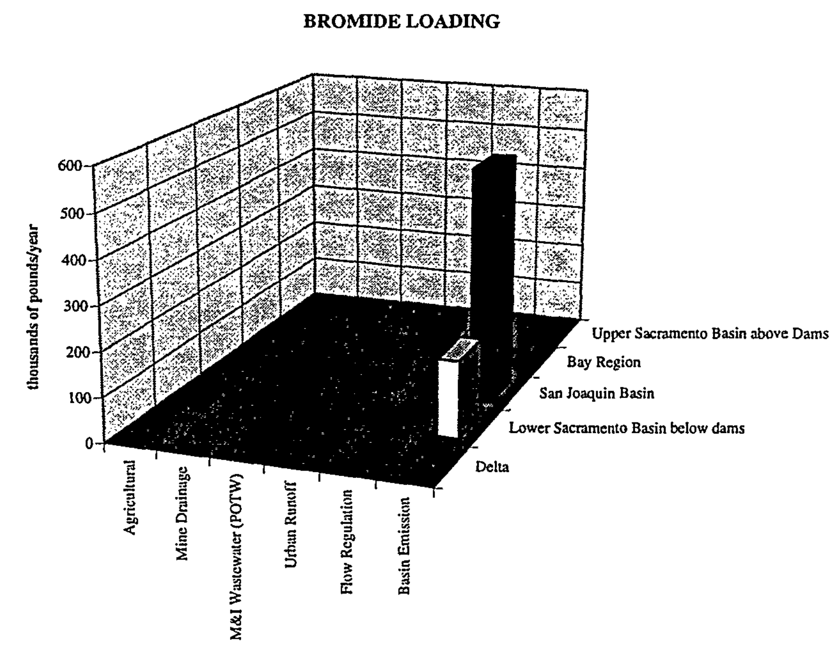
BROMIDE LOADING TABLE											
	Bromide Loading (pounds/year)										
Source	**Delta**	**Note**	**Lower Sacramento Basin below dams**	**Note**	**San Joaquin Basin**	**Note**	**Bay Region**	**Note**	**Upper Sacramento Basin above Dams**	**Note**
Agricultural										
Mine Drainage										
M&I Wastewater (POTW)										
Urban Runoff										
Flow Regulation										
Total Load										
Basin Emission			172	*a*	535	*b*				

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

Data available; flow and concentration data available; load calculations required.

Further literature review required.

- Source does not contribute significant load of constituent in this watershed.



Bromide Loading Notes

a. Concentration data was received from Ray Tom of the Department of Water Resources. Concentrations data was collected at Green's Landing for the Sacramento River and Vernalis for the San Joaquin River. Flow data is from USGS Water Data Reports for the years in which concentration data was available.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate

b. See note a for explanation.

CADMIUM LOADING TABLE

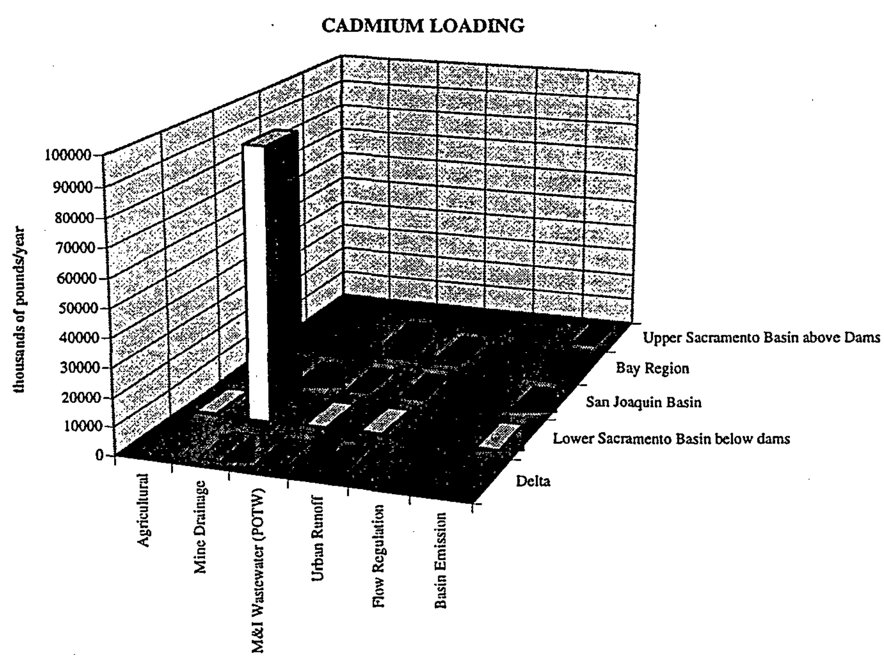
	Cadmium Loading (pounds/year)									
Source	**Delta**	**Note**	**Lower Sacramento Basin below dams**	**Note**	**San Joaquin Basin**	**Note**	**Bay Region**	**Note**	**Upper Sacramento Basin above Dams**	**Note**
Agricultural			655	*d*						
Mine Drainage	36	*a*	96,000	*e*	36	*i*				
M&I Wastewater (POTW)	154	*b*	270	*f*	202	*j*	6394	*m*		
Urban Runoff	136	*c*	582	*g*	191	*k*	2535	*n*		
Flow Regulation										
Total Load	326		97,507		429		8929			
Basin Emission			11	*h*	2	*l*			200	*o*

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

Data available; flow and concentration data available; load calculations required.

Further literature review required.

- Source does not contribute significant load of constituent in this watershed.



Cadmium Loading Notes

a. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and load data was compiled for four inactive mines including Iron Mountain, Newton, New Idria and Afterthought Mines. Only mines that drain to the Sacramento River or its tributaries below Shasta, Oroville and Nimbus Dams were considered. Eighty-five percent of the load was from Iron Mountain. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier mine drainage estimate only represented 25% of the total. A further review of the two RWQCB documents was made by Woodward-Clyde in light of information contained in a 1992 report by the Central Valley Board entitled "Inactive mine drainage in the Sacramento Valley". Data in this report suggests that mine drainage represents about 50% of the total cadmium load from inactive mines. The 50% estimate was used to scale up the loads originally calculated by RWQCB. The loads calculated in the 1988 RWQCB were segregated into the three geographical areas, delta, San Joaquin Basin and Sacramento Basin below dams.

b. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and load data was compiled from several NPDES dischargers who have been monitoring copper. including the largest in the Central Valley the Sacramento Regional County Sewer District. Woodward-Clyde divided the results into two geographical areas, the delta and the Sacramento Basin. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier M and I estimate only represented 50% of the total. This percentage was used to scale up the loads.

c. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Urban runoff estimates were made for 19 large cities in the Central Valley. Flow data was calculated using rainfall data for cities, urban acreage and a runoff factor of 0.3. Quality data for the city of Sacramento was used for all cities. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier urban runoff estimate only represented 35% of the total. A further review of the original data by Woodward-Clyde concluded that the original estimate probably captured 70% of the load, because all major urban areas were included in the calculations. The 70% figure was used to scale up the original estimates. The data allowed separation of the loads into three geographical areas, the delta, San Joaquin Basin and the Sacramento Basin.

d. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and concentration information was compiled for the major drains in the Sacramento Basin, including Sacramento Slough, Colusa Basin Drain, RD1000, RD108 and Natomas East Main Drain. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in

the Sacramento Valley, California, 1985" estimated that the earlier agricultural runoff estimate only represented 80% of the total. This percentage was used to scale up the estimates.

e. See note a for explanation.

f. See note b for explanation.

g. See note c for explanation.

h. Concentration data is from EarthInfo USGS Quality of Water databases on CD-ROM (EarthInfo, 1996). Flow data is from USGS Water Data Reports for the years in which concentration data was available. For the Sacramento River concentration and flow data used in the load calculation is from Freeport. For the San Joaquin River concentration and flow data used in the load calculation is from Vernalis.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate.

i. See Note a for explanation.

j. See Note b for explanation.

k. See Note c for explanation.

l. See Note h for explanation.

m. Reported in Table 19 of "State of the Estuary: A report on conditions and problems in San Francisco Bay/Sacramento-San Joaquin Delta Estuary' San Francisco Estuary Project, 1992. Middle of range of values used .

n. See Note mc for explanation.

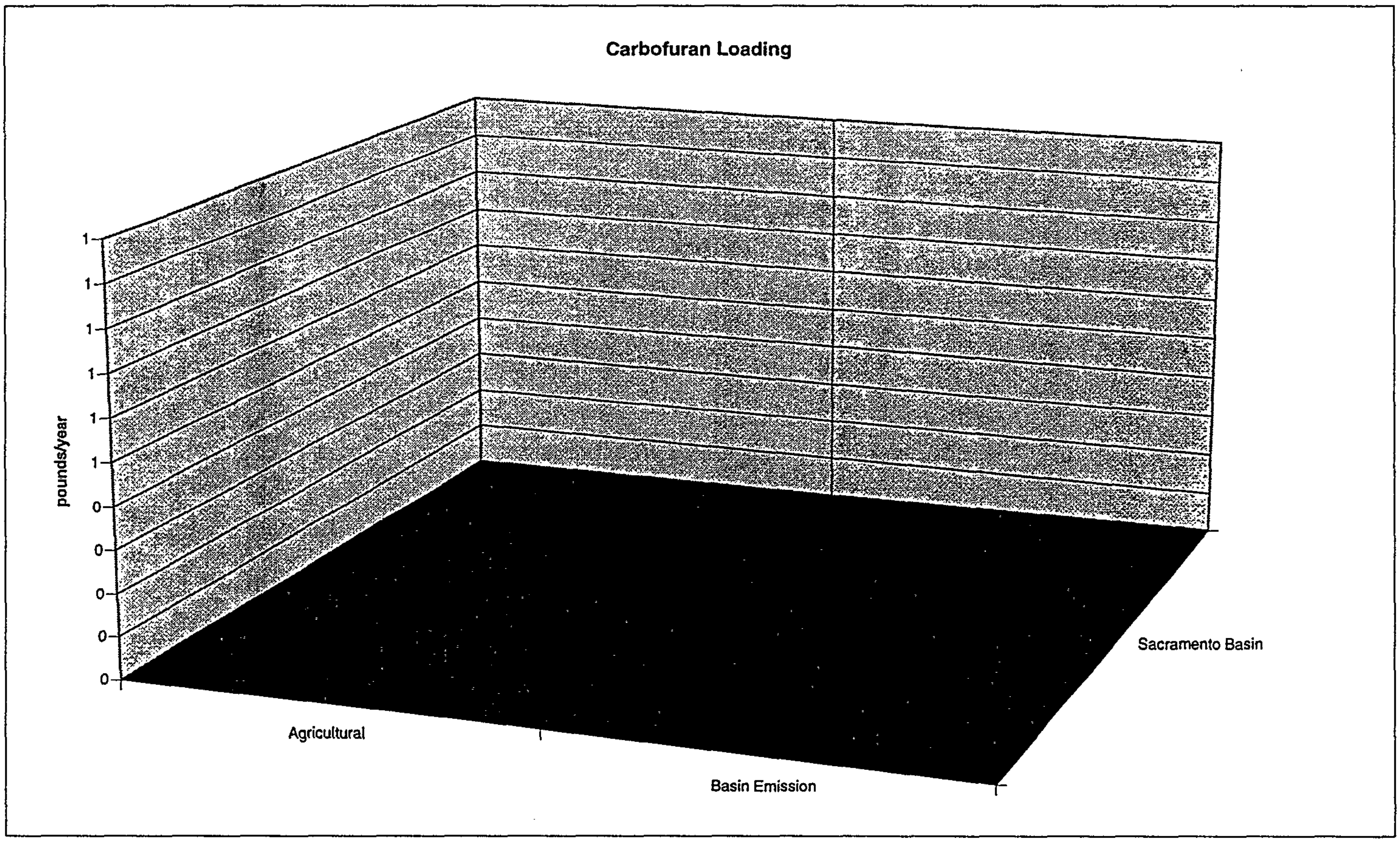
o. Total emission from upper Sacramento Basin was calculated using flow and concentration data for releases from Shasta, Oroville and Nimbus Dams. Reported in "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988.

CARBOFURAN LOADING TABLE		
	Carbofuran (pounds/year)	
Source	**Sacramento Basin**	**Note**
Agricultural		*a*
Total Load		
Basin Emission		*b*

Total Load

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

(hatched) - Data available; flow and concentration data available; load calculations required.



Carbofuran Loading Notes

General Notes

- Applied to alfalfa fields in March and to rice fields from April through June.

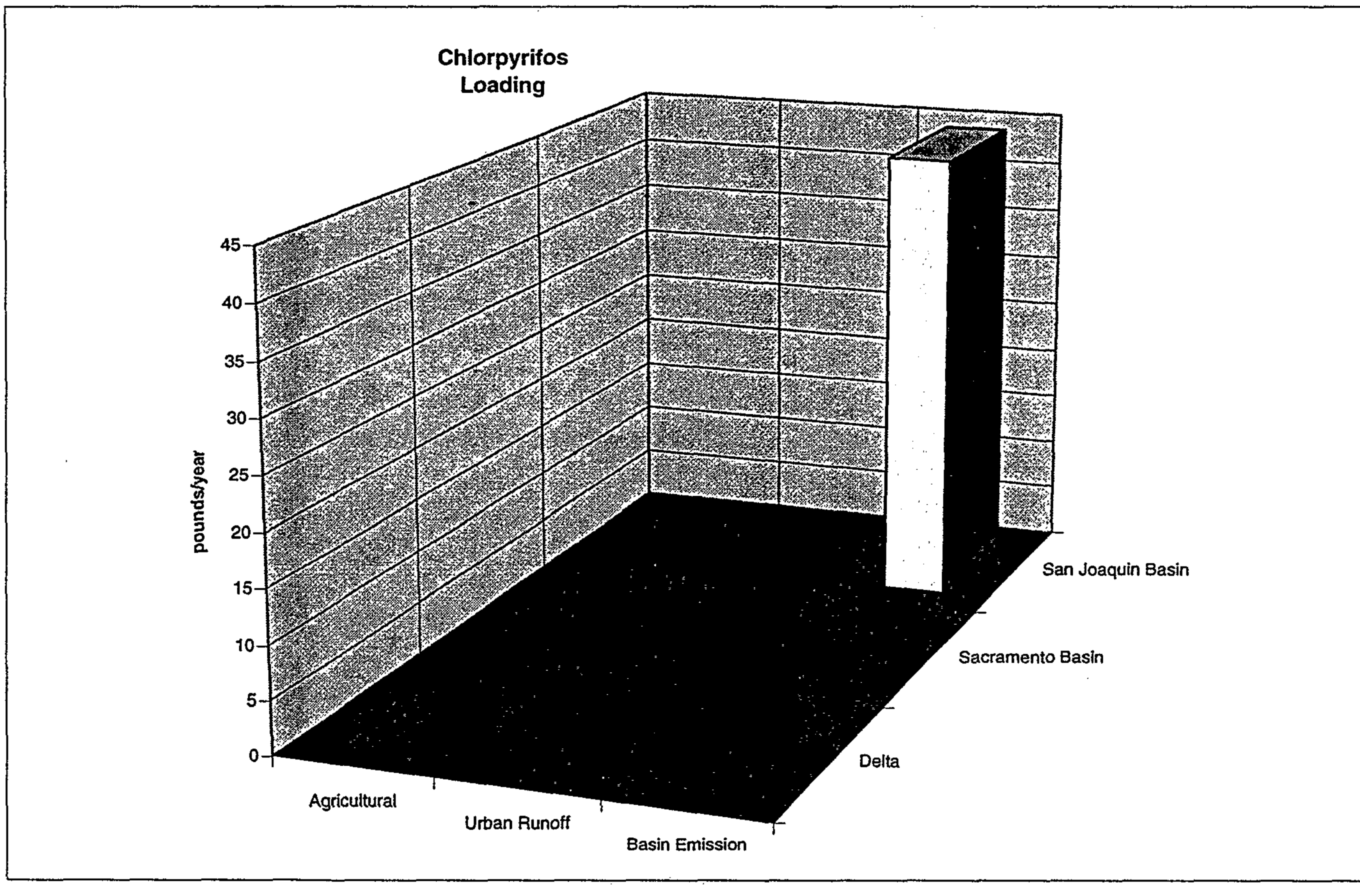
a. Several studies report carbofuran concentrations detected in the Sacramento River at various locations (USGS, 1995, Open File Report 95-110); (Crepeau et. al.); (Department of Fish and Game, Rice Pesticide Concentrations in the Sacramento River and Associated Agricultural Drains); (Department of Water Resources, August 1989). Discharge data is available for many of the locations where carbofuran was sampled. Load calculations are in progress.

b. See Note a for explanation.

CHLORPYRIFOS LOADING TABLE						
	Chlorpyrifos Loading (pounds/year)					
Source	**Delta**	**Note**	**Sacramento Basin**	**Note**	**San Joaquin Basin**	**Note**
Agricultural						
Urban Runoff						
Total Load						
Basin Emission					44	*a*

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

- Data available; flow and concentration data available; load calculations required.
- Further literature review required.
- Source does not contribute significant load of constituent in this watershed.



Chlorpyrifos Loading Notes

General Notes

- Applied to almond orchards in January and February and again in May through August.
- Applied to alfalfa fields in March.
- Particle bound compound.

a. Concentration data is from EarthInfo USGS Quality of Water databases on CD-ROM (EarthInfo, 1996). Flow data is from USGS Water Data Reports for the years in which concentration data was available. For the Sacramento River concentration and flow data used in the load calculation is from Freeport. For the San Joaquin River concentration and flow data used in the load calculation is from Vernalis.

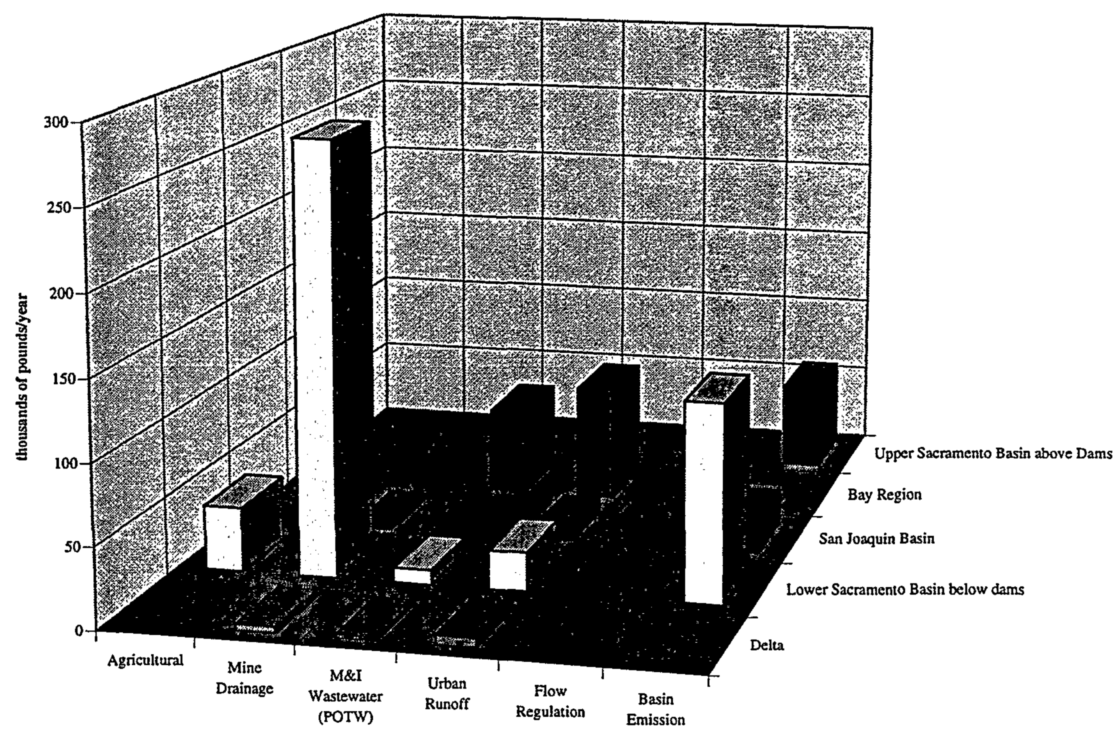
Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate.

COPPER LOADING TABLE											
	Copper Loading (thousands of pounds/year)										
Source	**Delta**	**Note**	**Lower Sacramento Basin below dams**	**Note**	**San Joaquin Basin**	**Note**	**Bay Region**	**Note**	**Upper Sacramento Basin above Dams**	**Note**
Agricultural			41	*e*						
Mine Drainage	4	*a*	274	*f*	4	*j*				
M&I Wastewater (POTW)	2	*b*	9	*g*			55	*m*		
Urban Runoff	6	*c*	24	*h*	9	*k*	73	*n*		
Flow Regulation										
Total Load	12		348		13		128			
Basin Emission		*d*	124	*i*	22	*l*			56	*o*

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

- Data available; flow and concentration data available; load calculations required.
- Further literature review required.
- Source does not contribute significant load of constituent in this watershed.



Copper Loading Notes

a. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and load data was compiled for four inactive mines including Iron Mountain, Newton, New Idria and Afterthought Mines. Only mines that drain to the Sacramento River or its tributaries below Shasta, Oroville and Nimbus Dams were considered. Ninety-five percent of the load was from Iron Mountain. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier mine drainage estimate only represented 25% of the total. A further review of the two RWQCB documents was made by Woodward-Clyde in light of information contained in a 1992 report by the Central Valley Board entitled "Inactive mine drainage in the Sacramento Valley". Data in this report suggests that Iron Mountain represents about 50% of the total copper load from inactive mines. The 50% estimate was used to scale up the loads originally calculated by RWQCB. The loads calculated in the 1988 RWQCB were segregated into the three geographical areas, delta, San Joaquin Basin and Sacramento Basin below dams.

b. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and load data was compiled from several NPDES dischargers who have been monitoring copper. including the largest in the Central Valley the Sacramento Regional County Sewer District. Woodward-Clyde divided the results into two geographical areas, the delta and the Sacramento Basin. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier M and I estimate only represented 50% of the total. This percentage was used to scale up the loads.

c. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Urban runoff estimates were made for 19 large cities in the Central Valley. Flow data was calculated using rainfall data for cities, urban acreage and a runoff factor of 0.3. Quality data for the city of Sacramento was used for all cities. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier urban runoff estimate only represented 35% of the total. A further review of the original data by Woodward-Clyde concluded that the original estimate probably captured 70% of the load, because all major urban areas were included in the calculations. The 70% figure was used to scale up the original estimates. The data allowed separation of the loads into three geographical areas, the delta, San Joaquin Basin and the Sacramento Basin.

d. Copper concentrations are available from various sampling locations within the Delta and at the San Joaquin River inflow to the Delta. Most of this data can be found at the Interagency Ecological Program web site. Work is in progress to acquire matching discharge data and calculate loads.

Copper Loading Notes

e. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and concentration information was compiled for the major drains in the Sacramento Basin, including Sacramento Slough, Colusa Basin Drain, RD1000, RD108 and Natomas East Main Drain. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier agricultural runoff estimate only represented 80% of the total. This percentage was used to scale up the estimates.

f. See Note a for explanation.

g. See Note b for explanation.

h. See Note c for explanation.

i. Concentration data is from EarthInfo USGS Quality of Water databases on CD-ROM (EarthInfo, 1996). Flow data is from USGS Water Data Reports for the years in which concentration data was available. For the Sacramento River concentration and flow data used in the load calculation is from Freeport. For the San Joaquin River concentration and flow data used in the load calculation is from Vernalis.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate

j. See Note a for explanation.

k. See Note c for explanation.

l. See Note i for explanation.

m. Reported in Table 19 of "State of the Estuary: A report on conditions and problems in San Francisco Bay/Sacramento-San Joaquin Delta Estuary' San Francisco Estuary Project, 1992. Middle of range of values used .

Copper Loading Notes

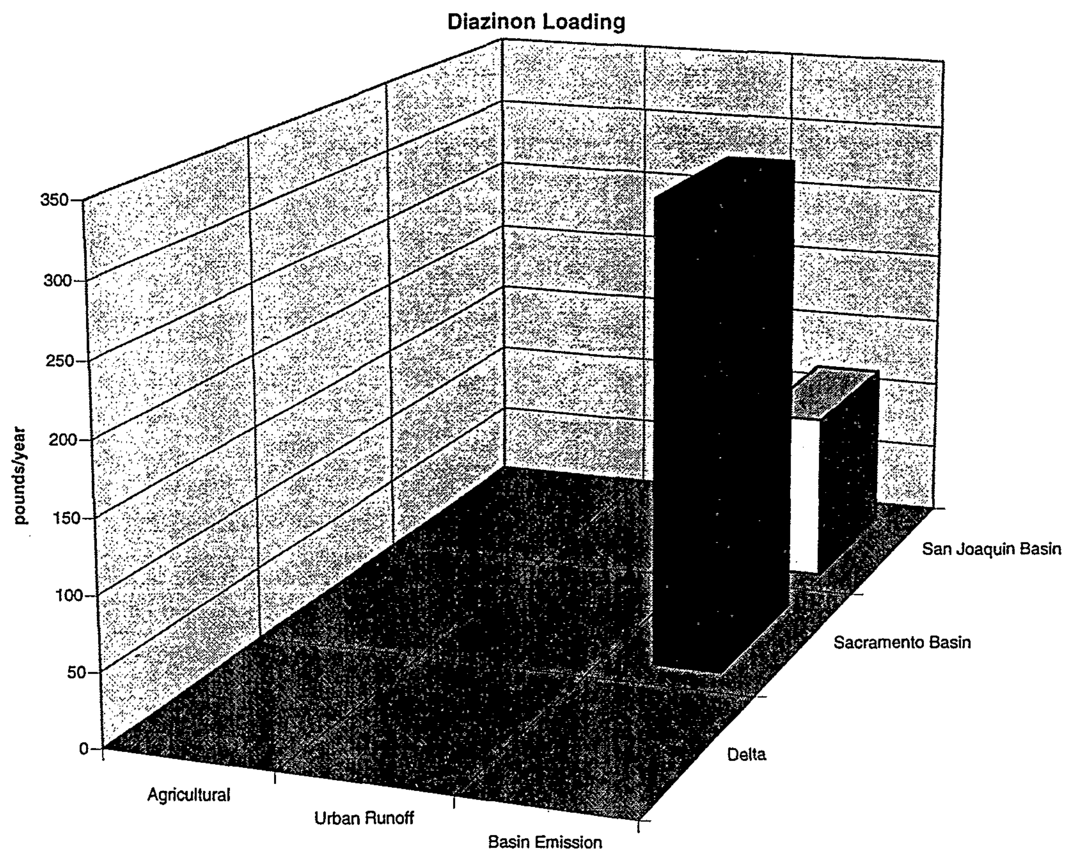
n. See Note m for explanation.

o. Total emission from upper Sacramento Basin was calculated using flow and concentration data for releases from Shasta, Oroville and Nimbus Dams. Reported in "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988.

DIAZINON LOADING TABLE						
	Diazinon Loading (pounds/year)					
Source	**Delta**	**Note**	**Sacramento Basin**	**Note**	**San Joaquin Basin**	**Note**
Agricultural						
Urban Runoff		*a*		*b*		
Total Load						
Basin Emission			319	*c*	116	*d*

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

- Data available; flow and concentration data available; load calculations required.
- Further literature review required.
- Source does not contribute significant load of constituent in this watershed.



C-036431

C-036431

Diazinon Loading Notes

General Notes

- Applied to almond orchards in January and February and again in May through August.
- Applied to alfalfa fields in March.

a. One study (Conner, 1996) reports diazinon concentrations in urban runoff from the cities of Stockton and Sacramento and the San Francisco Bay Area. The concentration from the City of Stockton could be used to calculate a load for the Delta. However, further investigation is required to determine if discharge data can be matched to the sampling events and locations.

b. See Note a for explanation.

c. Loads were estimated based on measured diazinon concentrations and measured streamflows. Diazinon concentrations in the San Joaquin River at Vernalis were obtained from The USGS WATSTOR database and the USGS Open File Report 95-110. Diazinon data in the Sacramento River at Sacramento were obtained from the USGS Open File Report 95-110. Flows in the Sacramento River are from the USGS gage at Freeport (#11447650).

d. Flows in the San Joaquin River are from the USGS gage at Vernalis (#11303500). At Vernalis loads were estimated for years 1991, 1993, and 1994. The average is reported in the table. At Sacramento loads were estimated for 1993 and 1994 and the average reported. Note, the estimated diazinon load at Sacramento includes urban runoff from Sacramento and surrounding areas in addition to agricultural runoff. Non-detect data was not included in the loads analysis.

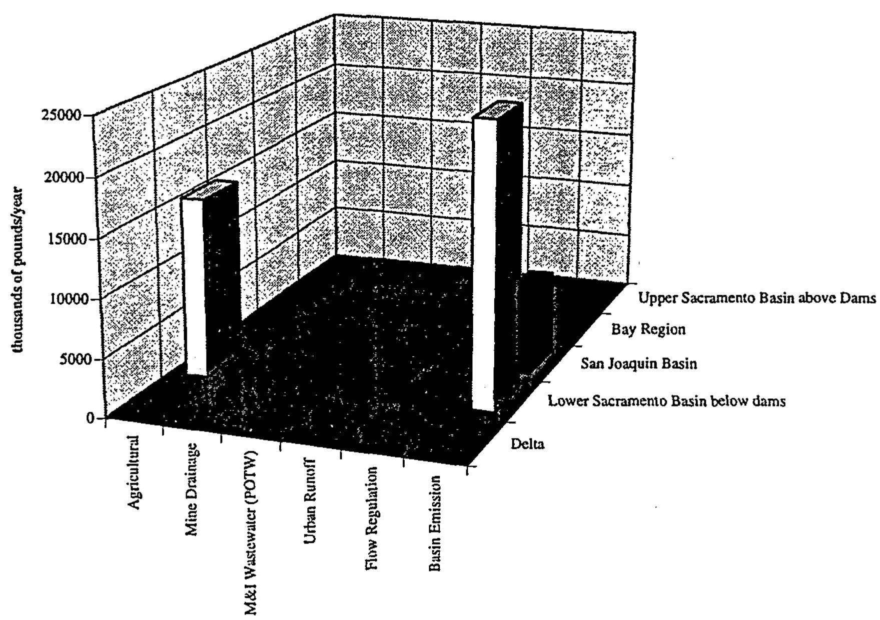
DISSOLVED ORGANIC CARBON (DOC) LOADING TABLE										
	Dissolved Organic Carbon (DOC) Loading (thousands of pounds/year)									
Source	**Delta**	**Note**	**Lower Sacramento Basin below dams**	**Note**	**San Joaquin Basin**	**Note**	**Bay Region**	**Note**	**Upper Sacramento Basin above Dams**	**Note**
Agricultural			15,558	*a*						
Mine Drainage										
M&I Wastewater (POTW)										
Urban Runoff										
Flow Regulation										
Total Load			15,558							
Basin Emission			24,380	*b*	7,100	*c*				

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

Data available; flow and concentration data available; load calculations required.

Further literature review required.

- Source does not contribute significant load of constituent in this watershed.



Dissolved Organic Carbon (DOC) Loading Notes

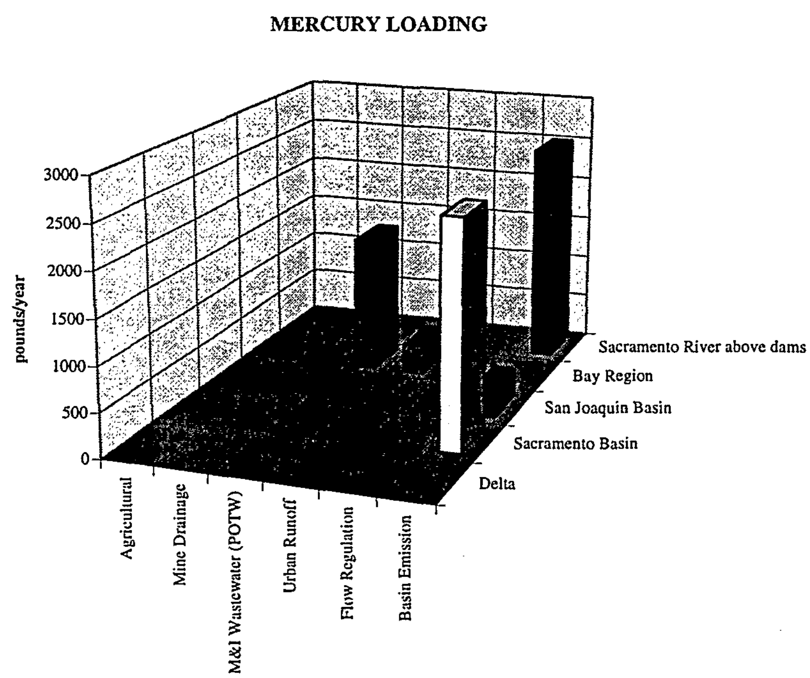
a. Load data was obtained from the "Study of Drinking Water Quality in Delta Tributaries" from the California Urban Water Agencies, April 1995 Report. The data estimated using Figure 4-1 which shows total loads of DOC and TOC and percentages for various contributing sources. The total in pounds per day in the Sacramento River at Greene's Landing is 310,000 lbs/day, 13.75 % of that is from agriculture. The data were evaluated using two techniques. One involves constructing and evaluating time-series plots for rainfall, flow, concentration and load allowing for a directs and detailed examination of seasonal and historical patterns and allow for a direct and detailed examination of periods when concentrations are high. The second technique included combining data from different sets of conditions/types of seasonal periods to average loads.

b. The "Study of Drinking Water Quality in Delta Tributaries", California Urban Water Agencies, April 1995 shows a 1.1 mg/L increase in DOC concentrations from agricultural drainage by comparing Inflow, Observed and Predicted DOC Five Years (1987-91) of Monthly Average DOC data. No flow data was supplied, therefore, no load calculations can be performed until further literature review has been performed.

c. A single sample reported in the Study of Drinking Water Quality in Delta Tributaries. California Urban Water Agencies, April 1995, was collected in 1989 (4.4-500mg/l) for urban runoff in Sacramento. No flow data available for this sample. Further data search must be performed to obtain additional TOC data information for load calculations.

MERCURY LOADING TABLE										
	Mercury Loading (pounds/year)									
Source	**Delta**	**Note**	**Sacramento Basin**	**Note**	**San Joaquin Basin**	**Note**	**Bay Region**	**Note**	**Sacramento River above dams**	**Note**
Agricultural										
Mine Drainage										
M&I Wastewater (POTW)							1543	*c*		
Urban Runoff							330	*d*		
Flow Regulation										
Total Load							1873			
Basin Emission			2530	*a*	328	*b*			2500	*e*

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load
- Data available; flow and concentration data available; load calculations required.
- Further literature review required.
- Source does not contribute significant load of constituent in this watershed.



Mercury Loading Notes

a. Concentration data is from EarthInfo USGS Quality of Water databases on CD-ROM (EarthInfo, 1996). Flow data is from USGS Water Data Reports for the years in which concentration data was available. For the Sacramento River concentration and flow data used in the load calculation is from Freeport. For the San Joaquin River concentration and flow data used in the load calculation is from Vernalis.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate

b. See Note a for explanation.

c. Reported in Table 19 of "State of the Estuary: A report on conditions and problems in San Francisco Bay/Sacramento-San Joaquin Delta Estuary' San Francisco Estuary Project, 1992. Middle of range of values used .

d. See Note c for explanation.

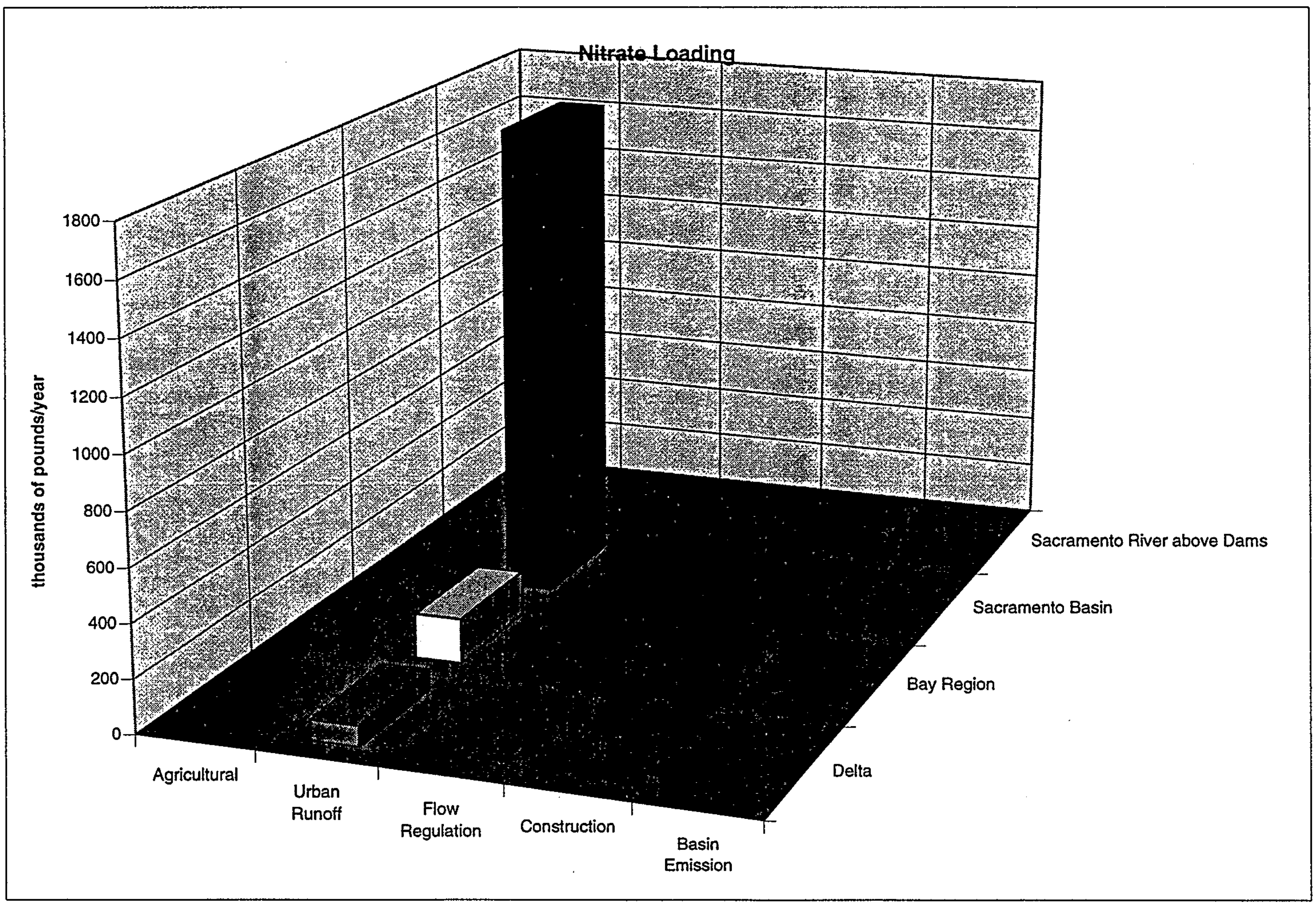
e. Emission was calculated using flow and concentration data for release from Shasta Dam. No similar data was available for Oroville and Nimbus Dams so this is probably an underestimate. Reported in "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. The emission is the product of a large flow and a small concentration, probably based on limited data. Consequently, a small error in concentration can greatly effect the emission rate.

NITRATE LOADING TABLE

Source	Delta	Note	Bay Region	Note	Sacramento Basin	Note	Sacramento River above Dams	Note
	Nitrate Loading (thousands of pounds/year)							
Agricultural								
Urban Runoff	77	*a*	166	*b*	1790	*c*		
Flow Regulation								
Construction								
Total Load	77		166		1790			
Basin Emission								

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

- Data available; flow and concentration data available; load calculations required.
- Further literature review required.
- Source does not contribute significant load of constituent in this watershed.



C-036437

C-036437

Nitrate Loading Notes

a. Nitrate loads were calculated by Woodward-Clyde for the Contra Costa Clean Water Program (Contra Costa Clean Water Program, 1994). The loads assessment model is based upon a relationship between rainfall quantities, runoff pollutant concentrations, and the relationship between pollutant loads and land use. The loads assessment model contains the following assumptions:

- Uniform precipitation between isohyets
- Constant runoff coefficient based upon land use
- Runoff water quality was constant for each land use
- Isohyetals based on average annual precipitation

The reported load in the loading table is from Figure 4-1 of the report (Contra Costa Clean Water Program, 1994).

b. See Note a for explanation.

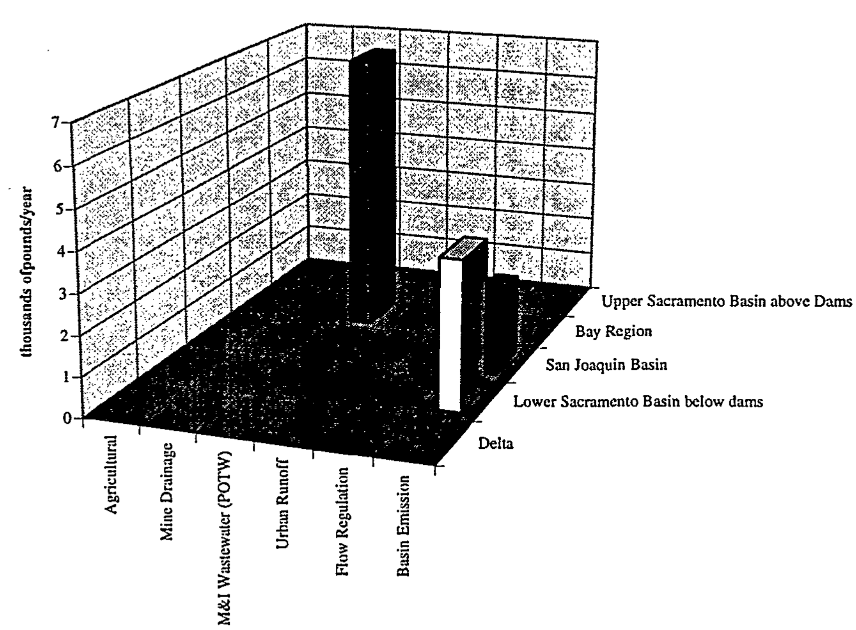
c. Nitrate loads were calculated for the Sacramento NPDES Stormwater Discharge Characterization Program (Larry Walker & Associates). Loads were initially calculated in 1992 using the following methodology:

- Regression models were developed showing the relationship of urban runoff pollutant discharge factors.
- The regression equations were then used as input to a continuous simulation model for Sacramento urban runoff mass loading over a 58 year period.
- The model was refined in 1996, using the updated database of urban runoff monitoring data available form the Sacramento NPDES Stormwater Monitoring Program. the load reported in the loading table is from Table 15 of the report (Larry Walker & Associates).

SELENIUM LOADING TABLE - 1										
	Selenium Loading (thousands of pounds/year)									
Source	Delta	Note	Lower Sacramento Basin below dams	Note	San Joaquin Basin	Note	Bay Region	Note	Upper Sacramento Basin above Dams	Note
Agricultural										
Mine Drainage										
M&I Wastewater (POTW)							7	*c*		
Urban Runoff										
Flow Regulation										
Total Load							7			
Basin Emission			4	*a*	2	*b*				

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

- Data available; flow and concentration data available; load calculations required.
- Further literature review required.
- Source does not contribute significant load of constituent in this watershed.



C-036439

C-036439

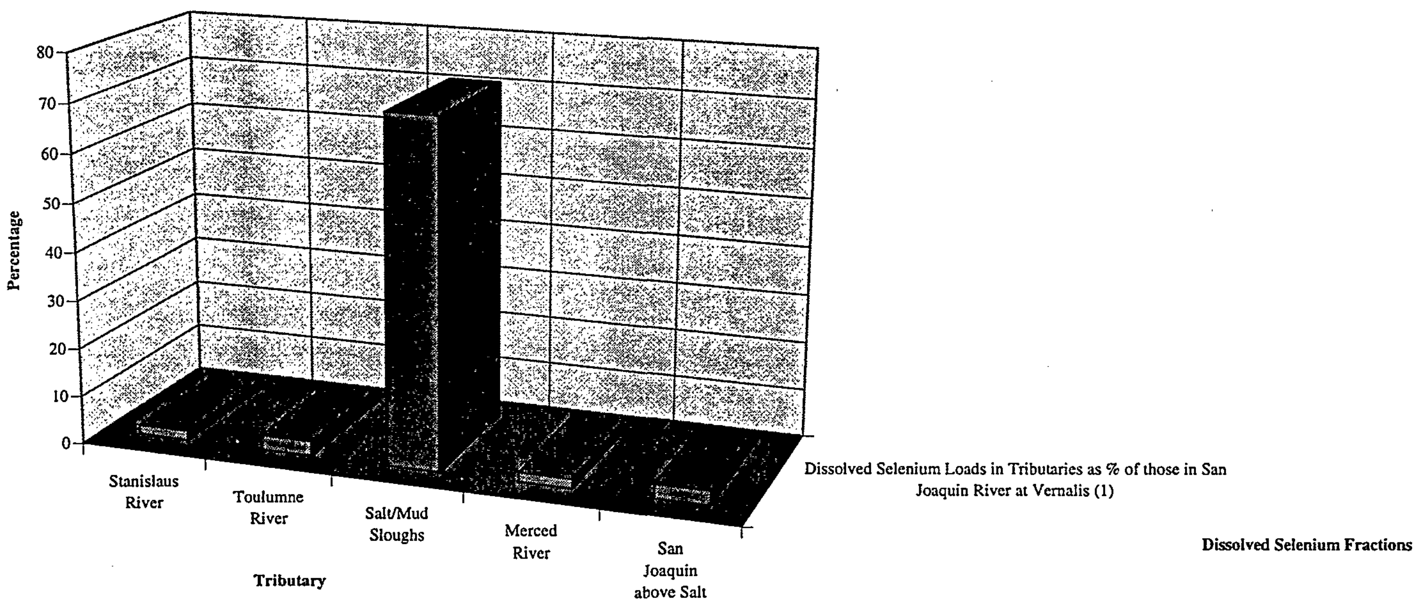
SELENIUM TABLE - 2	
Selenium in the San Joaquin River Tributaries	
Tributary	**Dissolved Selenium Loads in Tributaries as % of those in San Joaquin River at Vernalis (1)**
Stanislaus River	2
Toulumne River	3
Salt/Mud Sloughs	71
Merced River	2
San Joaquin above Salt Slough Confluence	3

Notes:

(1) Values obtained from the U.S. Geological Survey Water Resources Investigation Report 88-4186.

The dissolved selenium loads for the tributaries to the San Joaquin River do not add up to 100% of the loads in the San Joaquin River at Vernalis because some of the load at Vernalis most likely can be attributed to sources within the river, such as selenium delivered to the San Joaquin River from sources other than the listed tributaries.

SELENIUM IN THE SAN JOAQUIN RIVER TRIBUTARIES



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C-036440

Selenium Loading Notes

a. Concentration data is from EarthInfo USGS Quality of Water databases on CD-ROM (EarthInfo, 1996). Flow data is from USGS Water Data Reports for the years in which concentration data was available. For the Sacramento River concentration and flow data used in the load calculation is from Freeport. For the San Joaquin River concentration and flow data used in the load calculation is from Vernalis.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

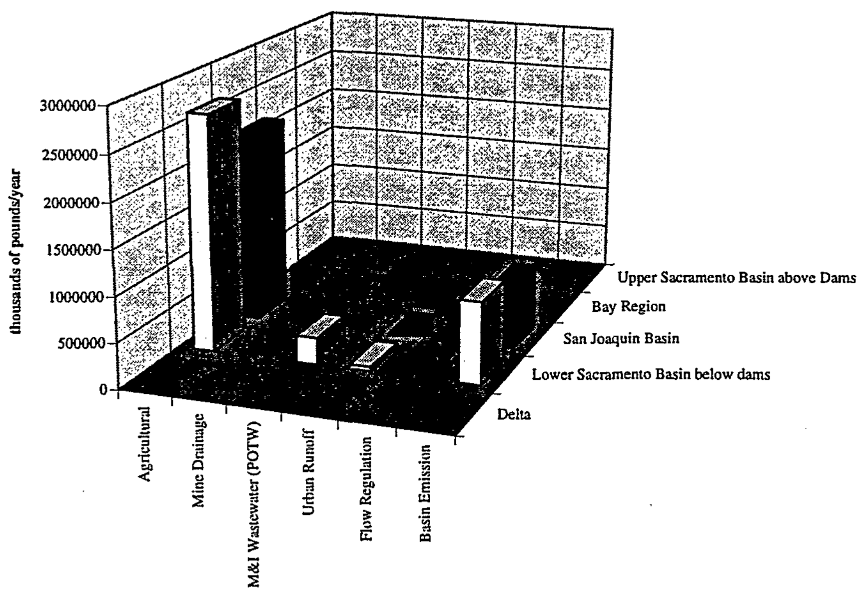
average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate

b. See Note a for explanation.

c. Selenium loads to San Francisco Bay are reported in "Mass Emissions Reduction Strategy for Selenium" prepared by San Francisco Bay RWQCB in 1992. The loads are estimated as 7.1 kg/day from oil refineries, 2.2 kg/day from municipal wastewater treatment plants and 2 kg/day from riverine sources under average flow conditions. No selenium was detected in samples of municipal wastewater. The RWQCB assumed that it was present in municipal wastewater at the detection limit used in the analyses and thus calculated 2.2 kg/day. The RWQCB noted this was a probable overstatement. It is worth noting that the estimated load to the bay from riverine sources (1,600 lbs/yr) is much lower than the sum of the Sacramento and San Joaquin River inputs to the Bay-Delta system (11,000 lbs/yr reported in "State of the Estuary: A report on conditions and problems in San Francisco Bay/Sacramento-San Joaquin Delta Estuary" San Francisco Estuary Project, 1992. Perhaps, this is attributable chemical reactions and biological uptake in the Delta.

TOTAL DISSOLVED SOLIDS (TDS) LOADING TABLE										
	Total Dissolved Solids (TDS) Loading (thousands of pounds/year)·									
Source	**Delta**	**Note**	**Lower Sacramento Basin below dams**	**Note**	**San Joaquin Basin**	**Note**	**Bay Region**	**Note**	**Upper Sacramento Basin above Dams**	**Note**
Agricultural			2,651,000	*a*	2,171,000	*e*				
Mine Drainage										
M&I Wastewater (POTW)			296,000	*b*						
Urban Runoff			42,330	*c*	296	*f*				
Flow Regulation										
Total Load			2,989,330		2,171,296					
Basin Emission			901,300	*d*	722,500	*g*				

·: All numbers are rounded to significant 4 digits
Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load
Data available; flow and concentration data available; load calculations required.
Further literature review required.
- Source does not contribute significant load of constituent in this watershed.



Total Dissolved Solids (TDS) Loading Notes

a. One study on drinking water quality in Delta tributaries calculated the relative proportions of TDS loads in the Sacramento River at Greene's Landing (California Urban Water Agencies, 1995). The load was subdivided into the following five categories: other sources, Sacramento Regional Wastewater Treatment Plant, Sacramento Combined Sewer Overflow, urban runoff, and the Sacramento Slough and Colusa Basin Drain. The load from Sacramento Slough and Colusa Basin Drain is assumed to be drainage from rice fields and therefore represents the agricultural load for the Lower Sacramento Basin.. The study calculated loads for both wet and dry years. The table contains an average for both years.

b. The portion of the load attributed to the Sacramento Regional Wastewater Treatment Plant in the drinking water study referenced in note represents a load from the area serviced by the plant. The load in the table does not represent a total load form all POTW's in the Lower Sacramento River Basin. The load value in the table is an average of wet and dry year loads.

c. The TDS concentration was developed from a continuous simulation analysis as a sum of the loads from wet weather, dry season and inter-storm loads (Larry Walker & Associates, 1996).

d. Concentration data was received from Ray Tom of the Department of Water Resources. Concentrations data was collected at Green's Landing for the Sacramento River and Vernalis for the San Joaquin River. Flow data is from USGS Water Data Reports for the years in which concentration data was available.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate

e. The study referenced in note a above also calculated loads for the San Joaquin River at Vernalis. The load was subdivided into contributions from Mud and Salt Sloughs and other sources. The load from Mud and Salt Sloughs is assumed to be agricultural drainage. The load value in the table is an average of wet and dry year loads.

f. One study (Fresno Metropolitan Flood Control District, 1995) estimated the annual pollutant loads, summing the loads from the San Joaquin River, Dry Creek and Bidon Canal.

g. See explanation for note d.

TOTAL ORGANIC CARBON (TOC) LOADING TABLE

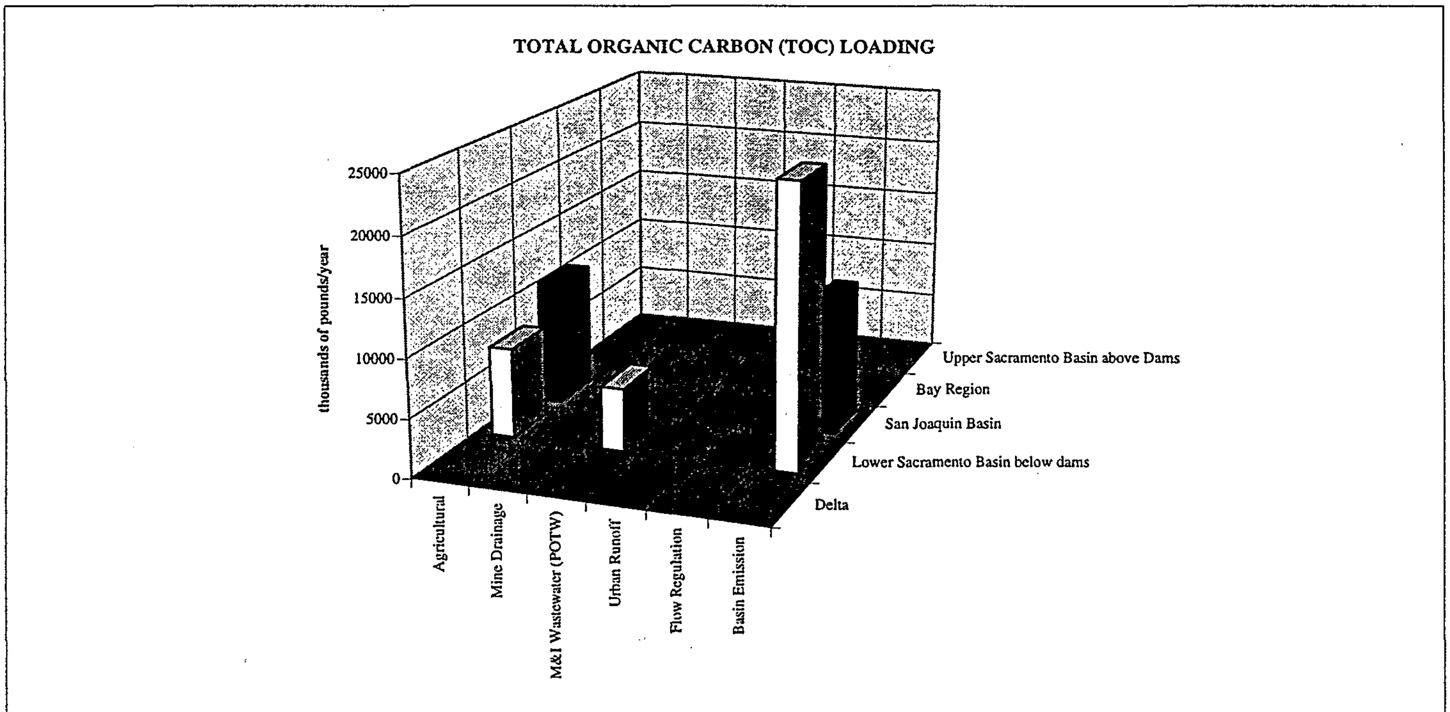
Source	Delta	Note	Lower Sacramento Basin below dams	Note	San Joaquin Basin	Note	Bay Region	Note	Upper Sacramento Basin above Dams	Note
	Total Organic Carbon (TOC) Loading (thousands of pounds/year)									
Agricultural			7706	*a*	10,764	*d*				
Mine Drainage										
M&I Wastewater (POTW)			5375	*b*						
Urban Runoff										
Flow Regulation										
Total Load			13,081		10,764					
Basin Emission			24,130	*c*	11,710	*e*				

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

Data available; flow and concentration data available; load calculations required.

Further literature review required.

- Source does not contribute significant load of constituent in this watershed.



C-036444

C-036444

Total Organic Carbon (TOC) Loading Notes

a. Load concentrations to the mud and salt sloughs from agriculture in the Sacramento Area were reported in the "Study of Drinking Water Quality in Delta Tributaries". (California Urban Water Agencies,1995). The value was obtained from Appendix D, Table D-7. The value used here is the highest value from the Table and in Wet year/wet season. The annual load was calculated assuming an average of 30,850 lb/day and 365 days in the wet season as defined in the study.

b. Load data was obtained from the "Study of Drinking Water Quality in Delta Tributaries" from the California Urban Water Agencies, April 1995 Report. The data estimated using Figure 4-1 which shows total loads of DOC and TOC and percentages for various contributing sources. The total in pounds per day in the Sacramento River at Greene's Landing is 310,000 lbs/day, 4.75 % of that is from agriculture. The data were evaluated using two techniques. one involves constructing and evaluating time-series plots for rainfall, flow, concentration and load allowing for a directs and detailed examination of seasonal and historical patterns and allow for a direct and detailed examination of periods when concentrations are high. The second technique included combining data from different sets of conditions/types of seasonal periods to average loads.

c. Concentration data was received from Ray Tom of the Department of Water Resources. Concentrations data was collected at Green's Landing for the Sacramento River and Vernalis for the San Joaquin River. Flow data is from USGS Water Data Reports for the years in which concentration data was available.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate

d. Load data was obtained from the "Study of Drinking Water Quality in Delta Tributaries" from the California Urban Water Agencies, April 1995 Report. The data estimated using Figure 4-1 which shows total loads of DOC and TOC and percentages for various contributing sources. The total in pounds per day in the San Joaquin River at Vernalis is 47,950 lbs/day, 61.51 % of that is from agriculture. The data were evaluated using two techniques. One involves constructing and evaluating time-series plots for rainfall, flow, concentration and load allowing for a directs and detailed examination of seasonal and historical patterns and allow for a direct and detailed examination of periods when concentrations are high. The second technique included combining data from different sets of conditions/types of seasonal periods to average loads.

Additional sampling has been conducted by the Department of Pesticide Regulations along the San Joaquin River. Sampling occurred periodically from March of 1991 through February of 1993. It can be assumed that these samples are being collected to estimate contaminants from agriculture. Concentration and flow data are available for values collected in the San Joaquin

River. Further Investigation on the locations of these monitoring stations and surrounding landuse will be performed prior to load calculations.

e. Concentration data is from EarthInfo USGS Quality of Water databases on CD-ROM (EarthInfo, 1996). Flow data is from USGS Water Data Reports for the years in which concentration data was available. For the Sacramento River concentration and flow data used in the load calculation is from Freeport. For the San Joaquin River concentration and flow data used in the load calculation is from Vernalis.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

The load was calculated using the equation in note c.

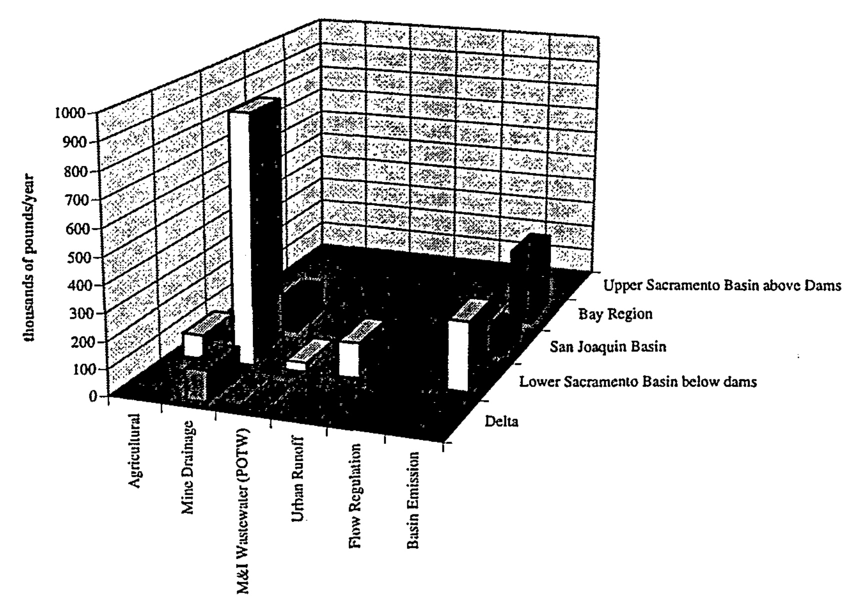
ZINC LOADING TABLE										
	Zinc Loading (thousands of pounds/year)									
Source	**Delta**	**Note**	**Lower Sacramento Basin below dams**	**Note**	**San Joaquin Basin**	**Note**	**Bay Region**	**Note**	**Upper Sacramento Basin above Dams**	**Note**
Agricultural			88	*c*						
Mine Drainage	116	*a*	930	*d*	116	*h*				
M&I Wastewater (POTW)	2	*b*	34	*e*						
Urban Runoff			131	*f*						
Flow Regulation										
Total Load	118		1183		116					
Basin Emission			255	*g*	69	*i*	279	*j*		

Note: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

Data available; flow and concentration data available; load calculations required.

Further literature review required.

- Source does not contribute significant load of constituent in this watershed.



Zinc Loading Notes

a. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and load data was compiled for four inactive mines including Iron Mountain, Newton, New Idria and Afterthought Mines. Only mines that drain to the Sacramento River or its tributaries below Shasta, Oroville and Nimbus Dams were considered. Eighty-five percent of the load was from Iron Mountain. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier mine drainage estimate only represented 25% of the total. A further review of the two RWQCB documents was made by Woodward-Clyde in light of information contained in a 1992 report by the Central Valley Board entitled "Inactive mine drainage in the Sacramento Valley". Data in this report suggests that mine drainage represents about 50% of the total zinc load from inactive mines. The 50% estimate was used to scale up the loads originally calculated by RWQCB. The loads calculated in the 1988 RWQCB were segregated into the three geographical areas, delta, San Joaquin Basin and Sacramento Basin below dams.

b. The original data for the load estimate was obtained from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1988. Flow and load data was compiled from several NPDES dischargers who have been monitoring copper. including the largest in the Central Valley the Sacramento Regional County Sewer District. Woodward-Clyde divided the results into two geographical areas, the delta and the Sacramento Basin. A later report by Central Valley RWQCB prepared in 1989 and entitled "A mass loading assessment of major point and non-point sources in the Sacramento Valley, California, 1985" estimated that the earlier M and I estimate only represented 50% of the total. This percentage was used to scale up the loads.

c. Loads were taken from "A mass loading assessment of major point and non-point sources discharging to surface waters in the Central Valley, California, 1985" prepared by the RWQCB Central Valley Region in 1989.

d. See note a for explanation.

e. See note c for explanation.

f. See note c for explanation.

g. Concentration data is from EarthInfo USGS Quality of Water databases on CD-ROM (EarthInfo, 1996). Flow data is from USGS Water Data Reports for the years in which concentration data was available. For the Sacramento River concentration and flow data used in the load calculation is from Freeport. For the San Joaquin River concentration and flow data used in the load calculation is from Vernalis.

Loads were calculated for each day data were available. For the period of record the average daily load was calculated from all the daily values. The annual load for the period of record is the product of the average daily load multiplied times the number of seconds in a year. The resulting value was converted to an average annual value by dividing the annual load for the period of record by the average daily flow over the period of record and then multiplying the result times the long term daily average flow rate.

average annual load = ((average daily load * number of seconds in a year) / average daily flow over the period of record)* long term daily average flow rate.

h. See note a for explanation.

i. See note g for explanation.

j. Estimate of Bay Region loads were made by adding estimated pollutant loads of Contra Costa, Alameda and Santa Clara Counties. This value probably underestimates the total contribution of zinc by the Bay Region.

6.0 DELTA REGION

6.1 Environmental Setting

The Central Valley is drained by the Sacramento River system to the north and the San Joaquin River system to the south. These two river systems converge into the Delta, which encompasses approximately 680,000 acres interlaced with approximately 700 miles of waterways (Arthur and Ball, 1978). Water flows from the Delta through the Suisun, San Pablo, and San Francisco bays to the Pacific Ocean at the Golden Gate Bridge. [4b]

The Delta is the West Coast's largest estuary, one of the country's largest systems for fish production, and provides habitat for more than 120 fish species. Drinking water is provided by the Delta for about 20 million people. Water flowing through the Delta is diverted by industries and more than 1,800 agricultural diversions located in the Delta. Freshwater not used in the Delta or not exported from the Delta, flows to the Pacific Ocean through San Francisco Bay. Freshwater outflows prevent saline water from encroaching into the Delta and degrading water quality. Delta channel geometry, inflows into and within the Delta, and tidal flows are interdependent variables that control seawater intrusion and water quality in the Delta.

Delta exports from the State Water Project (SWP) Banks pumping plant, SWP's North Bay Aqueduct on Barker Slough, the Central Valley Project (CVP) Tracy pumping plant, and Contra Costa Water District diversions at the Rock Slough intake supply water for agricultural, industrial, municipal, and some wildlife (e.g., refuge) uses. Diversions in Suisun Marsh are used to maintain waterfowl habitat units and leach salts from soil in winter. Industrial intakes and discharges occur near Sacramento, Stockton, and Antioch. Many public and private recreational facilities are located in the Delta and constitute an important part of the regional economy.

Variable hydrologic conditions, seasonal demands for water diversions, and agricultural drainage flows result in considerable fluctuations in Delta water supply and water quality conditions. Periods of high inflows that result in low salinity alternate with periods of low inflow that allow greater salinity intrusion and may allow larger effects from agricultural drainage. In the Delta, the distribution of inflowing dissolved and suspended materials is influenced by complex circulation patterns that are affected by channel geometry, flow volumes, pumping for Delta agricultural operations and exports, and tidal influence from the ocean. Under average hydrologic conditions, approximately 30% of Delta inflows is used for CVP and SWP exports, 10% is diverted for local uses, 20% is used for Delta outflow requirements, and 40% is additional Delta outflow that results from winter precipitation and runoff. The SWP and CVP export pumping plants exert a considerable influence on water circulation in the Delta by creating a net flow of water from northern regions of the Delta south through Old River and Middle River. During winter, inflow volumes exceed the export and other requirements and the Delta outflow is sufficient to repel the force of tidal encroachment. During late summer and fall, when low inflows and high agricultural pumping rates are occurring, flows can reverse direction in the central and western Delta channels. This pattern of "reverse flow" is a concern because of the potential effects on salinity.[2]

A major problem during periods of low Delta outflows is tidal mixing of salt into the Delta channels. Salts are a major concern with regard to municipal drinking water supplies because of the presence of bromide, which contributes to DBP formation, taste, and corrosion of plumbing and industrial facilities. Salts also are present in freshwater inflow and naturally occurring materials in Central Valley soils. The most heavily concentrated sources of agricultural drainage are the San Joaquin River basin and Delta islands.[2]

Delta water quality, particularly the concentration of pollutants, is strongly influenced by the operation of upstream reservoirs and diversions, including the CVP and SWP. On average, approximately 75-85% of Delta inflow is from the Sacramento River, 10-15% is from the San Joaquin River, and the eastside streams (e.g., Mokelumne, Cosumnes, and Calaveras) contribute the remainder. SWRCB biennial water quality assessment reports have consistently identified approximately 40 miles of the lower San Joaquin River from Vernalis to Stockton as a segment that does not fully support fishery-related designated uses because of water quality limitations (California State Water Resources Control Board 1992, 1994). San Joaquin River flows are often very low in late summer and fall. In contrast, the Sacramento River, the largest tributary to the Delta, has relatively good water quality because of the large amount of dilution provided by runoff from the watershed and releases from storage reservoirs.[2]

The chemical characteristics of Delta inflows depend on land use in the upstream watershed. Major potential sources of chemical and suspended constituents are natural and accelerated soil and channel erosion; drainage from irrigated agricultural fields, confined animal facilities, and rangeland; municipal wastewater effluent; past mining activities; industrial discharges; and urban stormwater runoff.

6.2 Water Quality Issues

Maintaining beneficial uses of Delta waters depends on the levels of several key water quality variables. Dominant water quality variables that can influence habitat and food-web relationships in the Delta are temperature, salinity, suspended solids (SS), dissolved oxygen (DO), dissolved organic carbon (DOC), pH, nutrients (nitrogen and phosphorus), chlorophyll, and toxic pollutants such as trace metals and synthetic organic compounds. **[2]**

The following water quality issues are recognized to be of concern in the Delta: **[2]**

- High-salinity water from Suisun Bay intrudes into the Delta during periods of low Delta outflow. Salinity adversely affects agricultural, municipal, recreational, industrial, and ecological uses.**[2]**

- Delta exports have elevated concentrations of DBP precursors (e.g., DOC), and the potential for formation of brominated DBPs increases along with increases in concentrations of bromide (Br^-), which originates in seawater.**[2]**

- Synthetic and natural contaminants have accumulated in Delta sediments and can bioaccumulate in fish and other aquatic organisms. Synthetic organic chemicals and heavy metals (e.g., mercury) are found in Delta fish in quantities that occasionally exceed acceptable standards for food consumption.[2]

- Agricultural drainage in the Delta contains high levels of nutrients, SS, DBP precursors (e.g., DOC), salinity, and traces of agricultural chemicals (pesticides). The San Joaquin River delivers water of relatively poor quality to the Delta; agricultural drainage to the river is a major source of salts and pollutants, including selenium, boron, and pesticides. The Sacramento River contains agricultural drainage, but in lower concentrations because river flows are higher. [2]

- Historical mining activities are a source of heavy metals, including cadmium, chromium, copper, mercury, and zinc. [2]

- Populations of striped bass and other species have declined significantly from historical levels. Causes of the declines are uncertain, although water quality conditions in the Bay and Delta (e.g., toxicity), decreases in Delta inflow and outflow rates, habitat loss, agricultural and other instream diversions, and increases in Delta exports are thought to be contributing factors. [2]

- The location of the estuarine salinity gradient and its associated "entrapment zone" (where biological productivity is relatively high because of the mixing and accumulation of suspended materials) is controlled by Delta outflow. The location of the entrapment zone affects the quantity and quality of habitat for estuarine species.[2]

6.3 Delta Water Quality Parameters of Concern

<u>6.3.1 Drinking Water</u>

Drinking water beneficial uses are impaired in the Delta and the Sacramento and San Joaquin Basins. Depending on location the impairment may be due to loading of bromide, nutrients, salinity, total organic carbon, turbidity, pathogens or changes in pH. Pathogens such as Cryptosporidium in source water can adversely affect municipal drinking water supplies. Nutrients such as organic carbon in source water can adversely affect municipal drinking water supplies by combining with water treatment disinfectants to produce harmful by-products (e.g., trihalomethanes). Nutrient loading can also impair the taste and odor of municipal water supplies. Solids loading is one mechanism by which pathogens, salts, and nutrients are transported into water bodies that provide water supplies. Therefore, elevated turbidity can be responsible for impairment of municipal water supplies.[1]

Agricultural drainage is of particular concern to drinking water because the peat soils of the Delta contribute organic chemicals to the agricultural drainage water. Delta island agricultural drainage in 1987 contributed up to 45 percent of the organic THM precursors (organic chemicals in raw water which contribute to the formation of THMs during the disinfection process) during April to August and more than 50 percent during the winter leaching period (California Department of Water Resources (DWR), 1991).[3]

Current intake structures for drinking water facilities are shown in Figure . These include the Contra Costa Pumping Plant at Rock Slough, the CVP Pumping Plant at Tracy, the Delta Cross Channel (DCC) at Walnut Grove, the SWP Banks Pumping Plant, the North Bay Aqueduct Pumping Plant.

6.3.2 Agriculture [Work in progress]

Agricultural beneficial uses

The location of current agricultural water supply intakes can be seen in Figure .

6.3.3 Environment

Environmental beneficial uses, specifically fishery resources, are impaired in the Delta.. Depending on location, the impairment may be due to loadings of metals, pesticides, pathogens, salts, solids, or nutrients. Metals, pesticides, salts, and ammonia in certain concentrations can exhibit toxicity to early life stages of fish and invertebrate species. Mercury can bioaccumulate in the upper levels of the food chain, affecting larger fish, birds and mammals. Pathogens can adversely affect fish either acutely (lethality) or chronically (histopathological effects, impaired reproduction). Solids can increase turbidity in water bodies, reducing photosynthesis and available food for fish. Solids can also cause siltation of water bodies, burying and ruining spawning gravels that are essential fish reproduction habitat. Nutrient loading can lead to direct or indirect depletion of dissolved oxygen in water bodies, which can suffocate aquatic organisms, and lead to observable fish kills. Nutrients such as organic carbon and ammonia directly deplete dissolved oxygen in water bodies as microorganisms use these substances for food and consume oxygen in the process. This combination of carbonaceous and nitrogenous organic material is often referred to as "biochemical oxygen demand" or BOD. Nutrients such as nitrate and phosphate can indirectly deplete oxygen if their loading leads to abnormal algae blooms (eutrophication) and subsequent die-off. **[1]**

6.3.4 Recreation

Recreational beneficial uses are impaired in the Delta. Depending on location the impairment may be due to loading of pathogens, metals, pesticides, solids, or nutrients. Microbial pathogens can adversely affect the health of those who are participating in water contact recreation, such as swimming or windsurfing. Pathogen contamination of fish or shellfish can adversely affect public health. Certain metals and pesticides, such as mercury and DDT, bioaccumulate in the food chain and can adversely affect recreational fishers who consume contaminated fish and shellfish. Solids loading or nutrient loading can increase the turbidity or odor of waters and interfere with the aesthetic enjoyment of these natural resources. Solids loading is also a mechanism by which pathogens, metals, pesticides, and nutrients are transported into waters that support recreational beneficial uses.**[1]**

Locations of public and private Delta recreational facilities can be seen in Figure .

6.3.5 Industrial [Work in Progress]

Industrial beneficial water uses may be impaired in the Delta.

Locations of industrial intakes can be seen in Figure .

The CALFED Water Quality Technical Group identified the following parameters as currently significant in impairing Delta beneficial uses of water. These “parameters of concern” are shown in Table 7.1. The list of parameters of concern for water quality may change over time to reflect new understanding of water quality issues in the Delta and its tributaries. **[1]**

Table 6.1. Summary of Delta Water Quality Parameters of Concern [1]

Drinking Water	Agriculture	Environmental	Recreational	Industrial
Bromide **Nutrients (Nitrate)** **Pathogens** **Salinity** **TOC** **Turbidity**	**Boron** **Chloride** **Nutrients (Nitrate)** **pH (Alkalinity)** **Salinity (TDS, EC)** **SAR** **Turbidity** **Temperature**	**Metals** **Cadmium** **Copper** **Mercury** **Selenium** **Zinc** **Organics/Pesticides** **Carbofuran** **Chlordane** **Chlorpyrifos** **DDT** **Diazinon** **PCBs** **Toxaphene** **Other** **Ammonia** **Dissolved Oxygen** **Salinity (TDS, EC)** **Temperature** **Turbidity** **Unknown Toxicity**	**Mercury** **DDT** **Toxaphene** **Chlordane** **PCBs** **Pathogens**	**Salinity** **pH**

6.4 Current Conditions [This section is a work in progress - all of the figures need checked and matched to the write-ups. Maps that show ranges for parameters throughout the Delta are being developed. VERY PRELIMINARY!

6.4.1 Temperature

Temperature governs rates of biochemical processes and is a major environmental factor in determining organism preferences and behavior. Water temperatures in the Delta are generally a function of the weather and runoff conditions. Delta temperatures are influenced only slightly by water management activities. The most common environmental impacts associated with water temperatures are localized effects caused by discharges at substantially elevated temperatures (e.g., thermal shock). Fish growth, activity, and mortality are related to their temperature tolerances. The Delta supports fish species, such as the chinook salmon and striped bass, that require different warm- and coldwater habitat conditions.[2]

6.4.2 Turbidity

The presence of suspended solids (often measured as turbidity) is a general indicator of surface erosion and runoff into water bodies or resuspension of sediment materials. Following major storms, water quality is often degraded by inorganic and organic solids and associated adsorbed contaminants (such as metals, nutrients, and agricultural chemicals) that are resuspended or introduced in runoff. Such runoff and resuspension episodes are relatively infrequent; persist for only a limited time; and, therefore, are not often detected in regular sampling programs. Large Delta inflows, sediment resuspension during dredging activities, agricultural drainage discharges, and suspended planktonic algae are the main causes of high SS concentrations.[2]

The attenuation of light in Delta waters is controlled by SS concentrations (with some effects from chlorophyll). These concentrations are often elevated in the entrapment zone as a result of increased flocculation (i.e., aggregation of particles) in the estuarine salinity gradient. High winds and tidal currents also contribute to increased SS concentrations in the estuary. Suspended sediments tend to suppress algae growth in much of the Delta (California State Water Resources Control Board 1995a). Figure 4 shows 1982-1995 turbidity values for the three export locations and at several locations in the San Joaquin River and Sacramento River inflows. Delta inflows often exceeded values observed in the Delta exports. Turbidity is higher in the western regions, as indicated by data from Rio Vista and Jersey Point.[2]

6.4.3 Dissolved Oxygen

DO concentrations serve as indicators of the balance between sources of oxygen (e.g., aeration and photosynthesis) and oxygen consumption (through decay and respiration processes). The DO concentration decreases with increasing temperature and often varies with the cycle of daily photosynthetic activity of algae and plants. DO concentrations in Delta channels are not generally considered a problem, except near Stockton and in some dead-end sloughs. DO concentrations in MWQI agricultural drainage samples were sometimes slightly below normal (e.g., less than 5 mg/l), indicating the presence of large quantities of decomposing organic material (measured by DOC).[2]

Considerable research has been conducted on the historical DO problems in the lower San

Joaquin River near Stockton. Water temperatures in late summer and fall often exceed 75-80°F, temperatures at which full DO saturation is approximately 8.0 mg/l. The available oxygen is then used by oxygen-demanding processes that lead to significant reductions in the DO levels. Channel sediments are believed to exert the greatest oxygen demand, followed by point sources (e.g., domestic and cannery wastewater discharges) and nonpoint sources of pollution. (City of Stockton 1996.) Reverse flows and stagnant conditions in this reach of the river exacerbate the problems. Installation of a temporary flow barrier at the head of Old River has helped alleviate DO problems downstream by increasing the amount of water moving downstream. In 1995, the Corps began operating an aeration device in the Stockton ship-turning basin to improve the DO conditions. The RWQCB is working with the City of Stockton to address DO effects from wastewater treatment plant effluent.[2]

6.4.4.Nutrients

Nitrates

Ammonia

6.4.5.pH

6.4.6 Sodium Absorption Ratio

6.4.7 Salinity (Electrical Conductivity and Total Dissolved Solids)

Salinity in drinking water is of concern because (1) bromide, a component of saline water, forms DBP precursors (bromide and total organic carbon); (2) there is a need for low salinity supplies to assure the feasibility of local wastewater reclamation and conjunctive use projects, (3) there is a need for low salinity supplies to minimize and retard the corrosion of infrastructure and appliances, and (4) there is a need for low salinity supplies to improve the aesthetics of drinking water (California Urban Water Agencies (CUWA)/CalFed, 1996). **[3]**

Salinity is of concern to agricultural water supplies because

Salinity is of concern to environmental water supplies because

Sources of marine water include salt water intrusion into the Delta from San Francisco Bay and conate groundwater. The magnitude of saline water intrusion is influenced by Delta outflow, which defines the upstream boundary of the salinity wedge. TDS loading has many sources; primarily seawater, agricultural drainage from the Delta, upstream agricultural drainage from sources on the Sacramento and San Joaquin rivers, and urban runoff. Urban runoff consists of dissolved minerals, whereas agricultural drainage is made up of soluble salts from irrigation water or leachate from the fields (CUWA, 1995).**[3]**

A recent study of Drinking Water Quality in Delta Tributaries (CUWA, 1995) evaluated benchmark concentrations and contaminant source concentrations in the lower Sacramento River, lower San Joaquin River, and the Delta. Benchmark TDS concentrations are presented in Table II-1. In general, the review concluded that there were no apparent significant seasonal trends. Instream flow does not alter TDS concentrations in the Sacramento River at Greene's Landing, although an inverse relationship exists in the San Joaquin River at Vernalis with higher instream flows having lower TDS concentrations. The primary contributors of TDS in the San Joaquin River basin are agricultural drainage from Mud and Salt sloughs. Peak TDS occurs during the peak irrigation month of July, followed by late fall and early winter TDS increases caused by agricultural drainage leachate.[3]

Agricultural drainage from Mud, Salt, and Sacramento sloughs and the Colusa Basin Drain are estimated to contribute 30 to 50 percent of the riverine TDS load to the Delta (CUWA, 1995). The remaining 50 to 70 percent are diffuse and/or unidentified. Riverine TDS loading from agricultural drainage sources could be altered with alternative management, although the effect to TDS concentrations at the Banks Pumping Plant is unknown due to TDS contributions from in-Delta and seawater sources (CUWA, 1995).[3]

TABLE [3]

BENCHMARK TDS CONCENTRATIONS IN THE LOWER SACRAMENTO AND SAN JOAQUIN RIVERS AND THE DELTA

Location	Concentration (mg/l)	Percent Contribution to the Delta (River)
Sacramento River at Greene's Landing	39 to 132	65 to 78
Natoma East Main Drain	225 to 674	(2)
Sacramento Slough and Colusa Basin Drain	70 to 314	(26 to 33)
Sacramento urban runoff	22 to 440	(2)
Sacramento combined sewer overflow	50 to 300	(2)
SRWTP	422 to 666	(2)
San Joaquin River at Vernalis	143 to 768	22 to 35
Mud and Salt sloughs	483 to 5180	(50)
Delta at Banks Pumping Plant	44 to 417	NA

Electrical Conductivity (EC), a general measure of dissolved minerals, is the most commonly measured variable in Delta waters. EC is generally considered a conservative parameter, not subject to sources or losses internal to a water body. Therefore, changes in EC values can be used to interpret the movement of water and the mixing of salts in the Delta. EC values increase with concentration, decrease with dilution, and may be elevated in agricultural drainage discharges and areas affected by seawater.[2]

Seawater intrusion from the estuary at Benicia has a substantial effect on salinity in the Suisun Bay portion of the estuary. The estuarine entrapment zone, an important aquatic habitat region associated with high levels of biological productivity, is defined by the mean daily EC range of about 2-10 millisiemens per centimeter (mS/cm) (Arthur and Ball 1980). The location of the estuarine salinity gradient and associated entrapment zone is estimated from EC monitoring data and is directly related to Delta outflow.[2]

Extensive historical data exist on EC from about 20 Delta locations. Figure 5 shows monthly average EC measurements in relation to flow in the Sacramento River at Green's Landing and in the San Joaquin River at Vernalis for water years 1968-1991. Average EC is generally 100-200 microsiemens per centimeter (μS/cm). Sacramento River EC measurements decrease with higher flows, exhibiting a typical flow-dilution relationship. The monthly average EC values for the San Joaquin River are usually higher than those for the Sacramento River, with typical values varying between 200 μS/cm and 1,000 μS/cm. Data indicate that EC measurements from the San Joaquin River at Vernalis also generally decrease with increases in flow.[2]

Figure 6 shows historical monthly EC patterns in the Delta and their relationship to effective outflows for 1976-1995 measured at Chipps Island. Pittsburg is downstream of the confluence of the Sacramento River and San Joaquin River near Chipps Island. The figure shows that periods of low Delta outflow correspond with major salinity intrusion episodes at Pittsburg, and periods of high Delta outflow correspond with salinity being flushed from the Delta.[2]

Tides and Salinity. The Delta is subject to tidal action and saltwater intrusion. Saltwater intrusion is governed by the flushing action of Delta outflow and the transport of salt upstream through tidal mixing exchange. Seawater intrusion has the greatest effect in the western portion of the Delta, but increased EC had been measured as far upstream as Courtland on the Sacramento River and Stockton on the San Joaquin River during critically dry years before CVP and SWP pumps were constructed (Smith, 1987). The western Delta and Bay region, where saltwater intrusion is greatest, historically has a high EC range.**[4b]**

Figure II-56 shows the historical pattern of monthly average EC at Benicia for 1967-1991. At Benicia, monthly average EC values range from less than 1,000 μS/cm during high Delta outflows to 30,000 μS/cm during low Delta outflows. Comparison with Figure II-55 demonstrates the relationship between monthly average effective Delta outflow and monthly average EC at Benicia. Considerable scatter in the pattern is the result of using monthly average EC values; the effects of daily changes in effective Delta outflow on EC are not always accurately described with monthly average values. The X2 location (EC of about 3 millisiemens per centimeter [mS/cm]) will be downstream of Benicia only at an effective Delta outflow greater than 50,000 cfs.**[4b]**

Figure II-57 shows the historical pattern of monthly average EC at Port Chicago (opposite Roe Island) for 1967-1991. Comparison with Figure II-55 shows the relationship between monthly average effective Delta outflow and monthly average EC at Port Chicago. The X2 location will be in the vicinity of Port Chicago during months with an effective outflow of 25,000 to 30,000 cfs.**[4b]**

Figure II-58 shows the historical pattern of monthly average EC at Pittsburg (near Chipps Island) for 1967-1991. The relationship between monthly average EC and monthly average effective Delta outflow is similar to that of Port Chicago. At Pittsburg, historical EC values have been approximately 3 mS/cm during months with an effective Delta outflow of approximately 8,000 cfs to 10,000 cfs.**[4b]**

Figure II-59 shows the historical pattern of monthly average EC at Collinsville (near the confluence of the Sacramento and San Joaquin rivers) for 1967-1991. At Collinsville, historical EC values have been approximately 3 mS/cm during months with an effective Delta outflow of approximately 7,000 cfs to 8,000 cfs.**[4b]**

Figure II-60 shows the historical pattern of monthly average EC at Emmaton for 1967-1991. The Emmaton monitoring station is located farther up the Sacramento River, where the extent of saltwater intrusion is reduced. Only during a few periods of low effective Delta outflow (approximately 3,000 cfs) did saltwater intrusion of 3 mS/cm extend up the Sacramento River as far as Emmaton.**[4b]**

Figure II-61 shows the 1967-1991 historical pattern of monthly average EC at Jersey Point. The Jersey Point EC monitoring station is located on the San Joaquin River downstream of Threemile Slough. Its salinity is similar to that at the Emmaton station on the Sacramento River side of Threemile Slough. Moderate levels of saltwater intrusion (3 mS/cm) have occurred only during periods of low effective Delta outflow (approximately 3,000 cfs).**[4b]**

The Contra Costa Canal Pumping Plant is located at the end of Rock Slough. Figure II-62 shows the monthly range of EC at the pumping plant for 1967-1991 along with the corresponding monthly average chloride concentrations at the Contra Costa Canal Pumping Plant. The 1995 WQCP includes an export EC objective of less than 1 mS/cm and a chloride objective of less than 250 mg/l, with a specified number of days per year less than 150 mg/l, depending on the water-year type. **[4b]**

Figure II-63 shows the monthly range of EC measurements in the Delta-Mendota Canal near the CVP Tracy Pumping Plant. Fluctuations in EC values are caused by periods of seawater intrusion, changes in San Joaquin River inflow EC, and agricultural drainage in the southern Delta.**[4b]**

Seawater intrusion and the movement of X2 is more dynamic than indicated by these monthly average EC and outflow values. For example, Figure II-65 shows daily 1985 Delta outflow in relation to historical daily EC values for several western Delta stations (Benicia, Port Chicago, Pittsburg, Collinsville, and Emmaton). The interpolated daily position of the EC gradient (entrapment zone) and the estimated X2 position are shown in Figure II-66 for 1985.**[4b]**

6.4.8 Chloride and Bromide

Seawater Intrusion and Bromide.
Most of the Delta islands are as much as 10 to 15 feet below mean tide level. Tides in the Delta not only threaten the protecting levees, but bring periodic intrusion of seawater, which mixes with the inflowing Delta freshwater. Tidal currents created by the rise and fall of sea levels modify stream flow, particularly when outflows are low or when tides are high (DWR,

IDHAMP, 1989). Intruded seawater is a major source of bromide, particularly in the western Delta. Bromide is a naturally occurring salt ion (halogen) of seawater origin and reacts with disinfectants to form DBPs. Thus, intrusion profoundly affects Delta water withdrawn at the Contra Costa Water District, SWP and CVP intakes.**[3]**

Seawater is the principal source of bromide in the Delta. Data for 1990 show that 84 to 98 percent of bromide in the California Aqueduct was of seawater origin. During that year, bromide in the Sacramento River measured at Greene's Landing, upstream of the Delta, ranged from 0.010 to 0.044 milligrams per liter (mg/l). At Banks Pumping Plant, measured levels of bromide concentrations ranged from 0.250 to 0.580 mg/l in some months, up to 58 times the Sacramento River concentrations (DWR, 1991).**[3]**

The presence of bromide in a drinking water source complicates the disinfection process. As with chlorine, bromide forms THMs in the chlorination process and these brominated THM's are also toxic to human health. Bromide is about twice as heavy as chlorine, and the THM standard is based on weight. Hence, it takes fewer molecules of brominated THMs to exceed the drinking water standard. Another method of disinfection, ozone treatment, is also complicated by the presence of bromide because it forms bromate, another undesirable DBP.**[3]**

Bromide contributes substantially to the formation of DBPs in treated drinking water from the Delta. Sources of Br^- in Delta water are seawater intrusion, San Joaquin River inflow containing agricultural drainage, and possibly connate groundwater (i.e., water trapped within sedimentary rocks that is often highly mineralized). Br^- has been measured by the MWQI program since January 1990.[2]

Salinity in the Delta derives from four major sources: seawater, San Joaquin River inflows, Sacramento River inflows, and local and upstream agricultural drainage. Concentrations of Cl^- and Br^- increase in proportion to EC values, and each Delta inflow can be characterized by a specific chemical composition. Available data indicate that the ratio of Cl^- to EC in each of the different Delta sourcewaters (e.g., Sacramento River, San Joaquin River, and seawater) is nearly constant and, therefore, can be used to distinguish the source of water sampled at different Delta locations. The Cl^-/EC ratio of agricultural drainage return flows depends on the source of the water used to irrigate the fields. Although evaporation and consumptive use increase the concentration of salts in drainage return flows, the overall Cl^-/EC ratio remains relatively constant. Where Br^- measurements are available, data indicate that all three sources of Delta water have a nearly identical and constant Br^-/Cl^- ratio of 0.0035. Variability in the Br^-/Cl^- ratio is greatest for the Sacramento River because of the low concentrations of Cl^- and Br^-.[2]

Chloride

The chloride concentrations and Cl^-/EC ratio in Delta inflows at Chipps Island and at the export locations for 1982-1995 are shown in Figure 7. In Sacramento River inflows, EC values are generally 100-200 μS/cm and Cl^- concentrations are usually 5-10 mg/l. The Cl^-/EC ratio averages 0.04 in the Sacramento River, and the average Br^- concentration is low (0.05 mg/l). In San Joaquin River inflows, EC values are much higher (150-1,300 μS/cm) and Cl^- concentrations fluctuate between about 20 mg/l and 150 mg/l. The Cl^-/EC ratio in the San

Joaquin River increases from about 0.08 at low EC values to about 0.15 at high EC values. The change in the Cl^-/EC ratio may be explained by the fact that San Joaquin River inflow is a mixture of San Joaquin River water, which contains significant amounts of agricultural drainage, and Stanislaus River water, which has a low average Cl^-/EC ratio and may therefore decrease the ratio in the San Joaquin River during seasonal periods of high runoff. The Cl^-/EC ratio has averaged about 0.30 for MWQI samples from Mallard Island, near the confluence of the Sacramento and San Joaquin Rivers, because a mixture of Sacramento River water and ocean water was presumably collected in the samples. Br^- concentrations would be about 17.5 mg/l at Mallard Island when Cl^- concentrations are 5 mg/l, resulting in a Br^-/Cl^- ratio of 0.0035. The Cl^-/EC ratio for seawater is approximately 0.35.[2]

The export Cl^- concentrations during the period ranged from 15 mg/l to 300 mg/l. The highest concentrations of export Cl^- generally coincided with elevated Cl^-/EC ratios. The only sourcewater with a Cl^-/EC ratio greater than 0.15 is seawater. Consequently, the data suggest that the dominant source of Cl^- during these periods is seawater. Contra Costa Water District water diverted from Rock Slough generally has a higher Cl^-/EC ratio than that found at other export locations.[2]

6.4.9 Total and Dissolved Organic Carbon

Organic materials enter the water from the following sources in the Delta in decreasing order of amounts.**[3]**

- natural materials, vegetation, and organics in soils
- agriculture, as vegetative organics in drainage
- urban runoff
- municipal and industrial wastewater discharges
- pesticides and herbicides

Organic carbon is one of the primary variables that influence the potential for DBP formation. Applicable drinking water standards are based on TOC concentrations; however, most of the available data for the Delta have focused on DOC. In general, most TOC in Delta waters is present in the dissolved form. The most common DBP is THM compounds formed during chlorination of DOC in drinking water supplies. These carcinogenic substances include chloroform and bromoform. MWQI studies have documented that Delta exports contain relatively high concentrations of DOC. Agricultural drainage discharges that contain natural organic matter from decomposing peat soil and crop residues are the major source of DOC in the Delta (California Department of Water Resources 1994b). Additionally, DOC is carried into the Delta from upstream inflows. Minimizing DOC concentrations in sourcewaters is a major water quality goal for drinking water uses to meet new EPA regulations for DBPs. Utilities must pretreat the sourcewater if TOC exceeds 2 mg/l at the water intake.[2]

Figure 8 shows data on export DOC from the MWQI program for three export locations and the major Delta inflows for 1987-1995. The values are lowest in the Sacramento River, averaging about 2 mg/l but occasionally exceeding 3 mg/l. The San Joaquin River and Delta export DOC range between 3 mg/l and 6 mg/l. The MWQI study concluded that Delta island drainage is a major source of DOC based on the high concentrations measured and the mass load estimated from historic drainage volumes. Contributions of DOC from crop residue, wetland plants, and peat soil leaching have been postulated but have not been measured.[2]

6.4.10 Metals and Toxic Elements

Heavy metals originate primarily from rocks and minerals, mining activities, and discharges of municipal and industrial wastes. Residues from heavy metals may produce serious pollution problems in the Delta because of toxic effects on fish and other aquatic organisms and may bioaccumulate in biological tissues. These residues can be measured in water, soils, sediments, and organisms that inhabit Delta channels. The detection of a particular compound depends on its persistence and mobility in the environment, as well as its source characteristics. SWRCB has characterized arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc as pollutants of concern because their widespread or repeated detection indicates their potential to cause adverse effects on beneficial uses in the estuary (California State Water Resources Control Board 1990). [2]

Mercury

Large amounts of mercury were used in the processing of gold, and riverine inflows originating in historic gold-mining areas continue to contribute mercury to Delta waterways. Natural deposits of mercury that were mined in the Cache Creek basin also contribute loading of the metal to Delta waters. SWRCB biennial water quality assessments list 48,000 acres of Delta waterways as impaired because of fish consumption advisories for mercury (California State Water Resources Control Board 1992, 1994). A health advisory for the consumption of striped bass from the Delta because of elevated levels of mercury in fish tissues has been in effect since the mid-1970s. [2] Ranges of mercury water column concentrations can be seen in Figure . Tissue levels ......

Cadmium, Copper and Zinc

The Delta receives large inputs of metals from historical mining activities in upstream watersheds. The sources of mining wastes along Spring Creek in the upper Sacramento River watershed contribute large loads of chromium, cadmium, copper, nickel, and zinc to the upper Sacramento River (California Department of Water Resources 1994a). The Iron Mountain Mine, in particular, contributes most of the cadmium, copper, and zinc transported in the Sacramento River. Ranges of cadmium, copper and zinc concentrations found at various locations in the Delta can be found in Figures .

Environmental beneficial uses in the Delta and the Sacramento and San Joaquin Basins are impaired by elevated levels of metals of concern. Urban runoff in the Central Valley and the Bay Area has exhibited toxicity to the test algal organism, Selanastrum. TIE studies **(ref-footnote)** with this species identified copper and zinc as causing toxicity. While urban and industrial runoff contribute significant loadings of copper and zinc, mine drainage is considered to be a more significant source of these metals to the Delta.**[1]**

Selenium

Selenium is an inorganic constituent of soils found in alluvium derived from rocks that originate on the ocean floor. It is particularly evident in the soils of the west side of the San Joaquin River basin. Relative to irrigation water, salts containing selenium tend to concentrate by 2-5 times in agricultural drainage. Selenium is leached out of soils as a result of irrigation and concentrates further when drainage return flows are stored in surface impoundments for long periods, or when irrigated land is inadequately drained. In 1983, high rates of waterfowl death and deformity were observed in Kesterson National Wildlife Refuge and were attributed to toxic concentrations of selenium in concentrated agricultural drainage.[2]

There is continued concern over San Joaquin River selenium transport from irrigated farm lands. Discharges from the Sacramento and San Joaquin Rivers are estimated to contribute two and a half times more selenium to the Bay-Delta estuary than municipal and industrial sources (Water Education Foundation 1996); the San Joaquin River contributes 4.2 metric tons and the Sacramento River contributes 1.1 metric tons. The drought years from 1987 to 1992 resulted in water supply restrictions for irrigators, increased irrigation efficiencies, and reduced flows to drainage channels. Whereas measured total quantities of selenium were reduced, the concentrations in the San Joaquin River remained elevated above the established water quality objectives. The lack of dilution capacity resulting from reduced natural inflows was attributed to the lack of change in concentrations despite the load reductions. In 1994, the mean monthly selenium concentration exceeded 10 μg/l in 10 of 12 months in the San Joaquin River upstream of the Merced River.[2]

6.4.11 Organics/Pesticides

Residues from organic pesticides and herbicides may produce serious pollution problems in the Delta because of toxic effects on fish and other aquatic organisms and may bioaccumulate in biological tissues. Similar to heavy metals, organic pesticides are detected in a variety of sample types, depending on the persistence and mobility of the particular compound. SWRCB biennial water quality assessments list Delta waterways as impaired because of elevated levels of pesticides (California State Water Resources Control Board 1992, 1994). Elevated levels of dioxin in the Delta are attributed to industrial discharges upstream in the Sacramento River basin (California State Water Resources Control Board 1995b, California Regional Water Quality Control Board 1996b). Most parameter concentrations in fish do not exceed standards established by the U.S. Food and Drug Administration or the National Academy of Sciences for the consumption of fish tissues. The presence of pollutants in fish demonstrates, however, that organic pesticides are bioaccumulating in the Delta food chain. [2]

Although pesticides are rarely detected in Delta water samples, data from various monitoring programs conducted by DWR and SWRCB have shown that contamination by synthetic organic chemicals is prevalent in sediment and organisms collected throughout the Delta. The TSMP has routinely detected chlorinated pesticides (e.g., DDT, toxaphene, and chlordane), the pesticides most resistant to chemical breakdown, in Delta sediments and biological tissue samples. Levels of these pesticides exceed identified thresholds for risk to humans, wildlife, or the biological receptors that come in contact with the pollutants (California State Water Resources Control Board 1995b). [2]

PCBs

(Write up and data to be inserted)

DDT
(Write up and data to be inserted)

Chlordane
(Write up and data to be inserted)

Toxaphene
(Write up and data to be inserted)

Carbofuran
(Write up and data to be inserted)

Chlorpyrifos
(Write up and data to be inserted)
Toxicity Identification Evaluation (TIE) studies of urban runoff have linked observed toxicity with the presence of diazinon and chlorpyrifos. Urban runoff in the Central Valley and the Bay Area has exhibited acute toxicity to the test organism, Ceriodaphnia. Both of these pesticides are widely available and have been detected simultaneously in urban creeks throughout the CALFED problem and solution areas. They are found in urban creeks throughout the year, but concentrations peak during the orchard dormant spray season (Foe, 1995). Ambient monitoring and composite rainfall samples suggest that the two pesticides come from both urban and agricultural sources.**[1]**

Diazinon
(Write up and data to be inserted)
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<u>6.4.12 Disinfection Byproducts in Treated Drinking Water</u>
THM compounds formed during chlorination of DOC in drinking water contain chloroform and bromoform. Chloroform, when administered at high doses, has been shown to increase the risk of liver and kidney cancer in mice (National Cancer Institute 1976). Using these data and considering water treatability, EPA has established a maximum contaminant level (MCL) of 100 μg/l or 100 parts per billion (ppb) for THMs in finished (treated) drinking water (44 FR 68624). The current MCL is under review by EPA and may be lowered in the near future. Proposed standards are an MCL of 80 μg/l for THM that would take effect in 1998 and an MCL of 40 μg/l to take effect in 2002, as well as MCLs for other DBPs (e.g., haloacetic acids, chlorite, and

bromate).[2]

The suspected carcinogenic risk to humans from THMs has led some communities to study and change their methods of disinfecting drinking water. THM levels in drinking water can be reduced by using alternatives to chlorination to treat water for human consumption (e.g., ozonation or chloramination), although other potentially harmful DBP compounds (e.g., bromate) may be formed during these disinfection processes. Disinfection itself is being more carefully regulated by EPA to avoid problems involving various pathogens (e.g., bacteria, viruses, and protozoa). Reducing DOC concentrations in raw water before chlorination with flocculation or granular-activated carbon adsorption can reduce all DBP levels but may be quite expensive.[2]

THM formation potential (THMFP) was measured in MWQI samples as an index of THM concentrations that could be produced by maximum chlorination of Delta water. Several types of laboratory tests have been developed to measure THMFP in water samples. Although THMFP is measured in raw (untreated) water, the regulatory requirement for THM concentrations applies to the finished (fully treated) water delivered to homes and commercial users. THM concentrations generally increase with higher chlorine doses and with higher DOC and higher Br^- concentrations (California Department of Water Resources 1994b).[2]

There are four types of THM compounds. A total THM concentration (by weight) of 100 μg/l is the basis for current EPA drinking water standards; however, the greater weight of Br^- causes more brominated THMs to be heavier and complicates the comparison of THM precursors from water samples with different Br^- concentrations. To normalize the total THM concentrations, MWQI studies include computed values of the total carbon weight of the four THMs. The carbon-fraction concentrations of the four THM molecules are added together to calculate the carbon equivalent of the THM concentration (C-THM), known as the trihalomethane formation potential carbon (TFPC) in the MWQI program. [2]

Figure 9 shows the 1982-1995 C-THM concentrations calculated by the MWQI study for the major Delta inflows and three export locations. Most Sacramento River C-THM values were below 30 μg/l; however, about one-third of the samples were above 30 μg/l. Most export samples were between 30 μg/l and 90 μg/l, generally higher than values in the Sacramento River. San Joaquin River samples were higher than Sacramento River samples, but not distinctly higher than Delta export concentrations. It is difficult to estimate the monthly source contributions to export C-THM concentrations because values in the inflows vary and no source concentrations are obviously larger than those found in Delta exports.[2]

6.4.13 Pathogens

Microbiological organisms of principal concern as agents of disease or indicators of potential contamination in drinking water include coliform bacteria, viruses and parasites.
Microbial agents have been responsible for waterborne outbreaks of infectious disease. Their presence in raw waters has been a principal thrust of water treatment technology. Waterborne diseases still occur in the United States. The Center for Disease Control (CDC) and EPA have estimated 1 million cases of illness per year and 1000 deaths per year due to waterborne

diseases.[3]

Bacteria
Principal waterborne bacterial agents that cause human intestinal disease are summarized in Table . Rather than analyze each of these pathogenic bacteria, water utilities routinely monitor for total and fecal coliform bacteria, an indicator organism. With few exceptions, these organisms, which originate in the intestinal tract of warm-blooded animals and other sources, are not pathogenic. Because coliforms are more abundant than pathogens in human waste by several orders of magnitude, the tests provide a margin of safety against pathogens. If coliforms are not detected, it is believed that bacterial pathogens would not be present, or at least they are likely to be below the levels known to infect. Although the tests have limitations, they are still the most widely used indicators of bacterial water quality.[3]

Viruses
In contrast to bacteria, enteric viruses are always assumed to be pathogenic. The prevailing theory is that only one infective unit (which may be as low as one virus) can cause infection. Because clinical symptoms are not always manifested and the link to a waterborne source is not easy, given difficulties in detecting viruses and considering that people are exposed to viruses from many sources, the extent of waterborne diseases due to viruses is not well quantified. The CDC estimates that of the 1 million of cases per year of illness from waterborne microorganisms, perhaps more than 50 percent are viral.[3]

Viruses of concern in drinking water are listed in Table . The enteroviruses (polio, Coxsackie A, Coxsackie B, and echoviruses), adenoviruses, reoviruses, the hepatitis viruses, and rotavirus can be detected by laboratory cell culture techniques. The norwalk agent cannot be detected by laboratory cell culture techniques. [3]

TABLE [3]

PRINCIPAL WATERBORNE BACTERIAL AGENTS AND ASSOCIATED HEALTH EFFECTS

Bacteria	Disease
Salmonella typhi	Typhoid fever
Salmonella paratyphi-A	Paratyphoid fever
Salmonella (other species)	Salmonellosis, enteric fever
Shigella dysenteriae, S. flexneri, and *S. sonnei*	Bacillary dysentery
Vibrio cholerae	Cholera
Leptospira sp.	Leptospirosis
Yersinia enterocolitica	Gastroenteritis
Francisella tularensis	Tularemia
Escherischia coli (specific enteropathogenic strains)	Gastroenteritis
Pseudomonas aeroginosa	Various infections
Enterobacteriacae (Edwardsiella, Proteus, Serratia, Bacillus)	Gastroenteritis
Campylobacter	Gastroenteritis

TABLE [3]

ENTERIC VIRUSES AND THEIR ASSOCIATED DISEASES

Virus Group	Number of Types	Common Disease Syndromes
Enteroviruses		
Polioviruses	3	Poliomyelitis, aseptic meningitis
Coxsackieviruses A	23	Herpangina, asepticmeningitis, exanthem
Coxsackieviruses B	6	Aseptic meningitis, epidemic myalgia, myocarditis, pericarditis
Echoviruses	31	Aseptic meningitis, exanthem, gastroenteritis
Adenoviruses	31	Upper respiratory illness, pharyngitis, conjunctivitis
Reoviruses	3	Upper respiratory illness, diarrhea, exanthem
Hepatitis viruses		
Hepatitis A Virus	1	Viral hepatitis type A or infectious hepatitis
Hepatitis B Virus	4	Viral hepatitis type B or serum hepatitis
Rotavirus	2	Gastroenteritis
Norwalk agent	1	Gastroenteritis

Parasites

Eggs and cysts of parasitic protozoa and helminths (worms) excreted into the environment may enter water supplies. All can severely disrupt the intestinal tract. Two of these are *Giardia lamblia* and *Cryptosporidium*. Their cysts/oocysts are far more resistant to disinfectants than bacteria or most viruses.[3]

Giardia lamblia. *Giardia lamblia*, the intestinal protozoan most frequently found in human populations worldwide, is the most commonly identified agent of water-borne diseases in the United States (Feachem, et al., 1983). Waterborne giardiasis has been increasing in the U.S. with 95 outbreaks over the last 25 years. Over 60 percent of all *Giardia lamblia* infections are believed to be acquired from contaminated water. *Giardia lamblia* cysts are found in water contaminated by fecal material from infected humans and animals. *Giardia lamblia* forms an environmentally resistant cyst that allows the parasite to survive in surface water and treated drinking water. Surveys of *Giardia lamblia* cyst levels in various waters found that 26 to 43 percent of surface waters were contaminated with *Giardia lamblia* cysts ranging from 0.3 to 100 cysts per 100 liters. From pristine watersheds (those protected from all human activity), cyst levels were 0.6 to 5/100 L. In raw sewage, an average of 1,000,000 cysts/100 L are reported, with an approximate reduction of 99 percent after treatment (Rose, et al., 1991).[3]

Ingestion of as few as 10 cysts can cause infection (Rendtorff and Holt, 1954). Infection was measured by the excretion of cysts, and illness was not determined. The ratio of illness to infection is highly variable. *Giardia lamblia* infections with no symptoms of illness may be as high as 39 percent for children under 5 years old and 76 percent for adults in certain populations (Craft, 1981; and Wolf, 1979; as reported in Rose, et al., 1991). At the same time, symptomatic infections have been reported at a rate of 50 to 67 percent and as high as 91 percent in others (Veazie, et al., 1979, as reported in Rose, et al., 1991). In yet other groups, chronic giardiasis may develop in as many as 58 percent of an infected population.[3]

Cryptosporidium. *Cryptosporidium*, an intestinal protozoan parasite, was first identified in 1907, but has been recognized to cause diarrheal disease in humans only since 1980. The first documented waterborne outbreak of cryptosporidiosis in humans occurred in the U.S. in 1985. In January 1988, EPA added *Cryptosporidium* to the Drinking Water Priority List.[3]

The severe gastro-intestinal symptoms of the disease last an average of 12 days, and are self-limiting in people with normal immune function. Illness patterns vary with age, immune status, and variations in the virulence of *Cryptosporidium.* Young mammals are more susceptible. For AIDS and cancer patients, cryptosporidiosis can cause mortality. The oocyst (infective stage) dose necessary to cause an infection in humans is unknown, but may be low; in a primate study, two individuals became infected after exposure to only 10 oocysts (Miller, et al. 1986). No effective treatment for the disease exists.[3]

Cryptosporidium is transmitted between humans and warm-blooded animals, including cats, dogs, cattle, goats, mice, pigs, rats, and sheep (Fayer and Ungar, 1986, as reported in Rose, 1991). *Cryptosporidium* from birds will not infect mammals, however. Common sources of *Cryptosporidium* in water are wildlife in a watershed, sewage discharges, and domestic animals (including runoff from grazing lands and dairies). For example, surface water running through cattle pastures can contain up to 6,000 oocysts per liter (Madore, et al., as reported in Peeters, et al., 1989).[3]

The protozoan appears everywhere in the water environment. In a survey of waters in the western U.S., 91 percent of sewage samples, and 77 percent of rivers and 75 percent of lakes receiving wastewater discharges or agricultural pollution were found to contain oocysts at varying levels (Rose, 1988). Even 83 percent of pristine water supplies with no human activity in the watershed contained *Cryptosporidium* oocysts. Limited samples of treated drinking water reported 28 percent of the samples contained oocysts. The levels of oocysts in these waters are shown in Table .[3]

TABLE [3]

CRYPTOSPORIDIUM OOCYSTS IN TYPICAL U.S. WATERS

Water Source	Percent of Samples Positive for Oocysts	Average Oocysts per Liter (1)
Sewage, raw	91	4 - 5180
Sewage, treated	91	4 - 1297
Streams/Rivers	77	0.94, 1.09, 1.3
Lakes/Reservoirs	75	0.58, 0.91
Pristine Rivers	83	0.02, 0.08
Treated Drinking Water	28	0.002, 0.009

NOTES:
(1) Geometric means of samples.

SOURCE:
Rose, 1988.

Cryptosporidium in drinking water resists chlorine disinfection. In addition, *Cryptosporidium* levels do not correlate well with indicator coliform bacteria levels, so meeting standards for coliforms and turbidity (a measure of the reduction of clarity of a water by suspended particles) may not be a sufficient measure of treatment reliability for removal of *Cryptosporidium*.[3]

Normal levels of chlorine in drinking water have been shown to be ineffective for inactivating *Cryptosporidium*, even after 18 hours of contact. However, ozone and chlorine dioxide have been found to be more effective disinfectants (Peeters et al., 1989). Sand filtration alone reduces but does not completely eliminate oocyst concentrations. Filtration with coagulation achieves greater removals.[3]

The Metropolitan Water District of Southern California (MWD) conducted a pathogen monitoring survey of selected upstream and downstream sites in the SWP/Delta system from April 1992 through April 1993. The study evaluated the following sites that potentially affected pathogen loading in the water system, including:[3]

- Greene's Landing, which represents water prior to entering the Delta, located 10 miles downstream from City of Sacramento wastewater discharges;[3]
- Banks Pumping Plant (Milepost 3.3), #8 II-9: which monitors SWP water quality introduced at the Banks Pumping Plant;[3]
- Delta-Mendota Canal (Milepost 67), which monitors water being transferred to the San Luis Canal at O'Neill Pumping Plant; and [3]
- Aqueduct Checkpoint 29, which represents a site immediately above the southern California area.[3]

A total of 48 samples was collected and analyzed for *Giardia lamblia* cysts, *Cryptosporidium* oocysts, enteric viruses and coliform bacteria. The percent positive and mean concentrations (cysts(ondocysts)/100 l) at each of the four stations for protozoans are shown in Table .[3]

TABLE [3]

PERCENT POSITIVE AND MEAN CONCENTRATION RANGE OF *GIARDIA LAMBLIA* CYSTS AND *CRYPTOSPORIDIUM* OOCYSTS AT FOUR SITES

	Giardia lamblia		*Cryptosporidium*	
	Percent Positive	**Mean (Range) Conc.**	**Percent Positive**	**Mean (Range) Conc.**
Greene's Landing	42	37 (8-82)	50	50 (5-132)
Banks Pumping Plant	0	0 (NA)	25	54 (32-70)
Delta-Mendota Canal	8	6 (6)	58	40 (9-92)
Aqueduct Checkpoint 29	0	0 (NA)	8	17 (17)

Means and ranges for total and fecal coliform bacteria concentrations at the four sites are shown in Table [3]

In general, these results suggest that the highest coliform activity occurred at Greene's Landing and the lowest at Aqueduct Checkpoint 29. This relationship was also evidenced for Giardia lamblia and Cryptosporidium. Moreover, two of the three positive enteric virus samples were recovered at Greene's Landing. The source of pathogens at Greene's Landing is not known, but may include effluent from upstream sewage treatment plants, release of sewage from boats, upstream recreational activity, and nonpoint fecal discharge.[3]

TABLE [3]

MEAN CONCENTRATION AND RANGE FOR TOTAL COLIFORMS AND FECAL COLIFORMS AT FOUR SITES

	Coliform Concentration Mean (Range)	
	Total Coliforms (MPN/100 mL) (1)	Fecal Coliforms (MFL/100 mL)
Greene's Landing	666 (140-1600)	24 (1-120)
Banks Pumping Plant	112 (11-500)	76 (0-310)
Delta-Mendota Canal	268 (13-1600)	16 (0-100)
Aqueduct Checkpoint 29	20 (2-50)	11 (0-99)
NOTE: (1) Most Probable Number/100 milliliters.		

MWD also conducted a pathogen monitoring survey of reservoirs in southern California receiving State Water Project water and Colorado River water. The results indicated that in both source waters, as measured downstream of Banks Pumping Plant, the levels of *Giardia lamblia* cysts ranged from 0 to 1.5 cysts/100 L with a mean of 0.05 cysts/100 L. Cryptosporidium oocysts ranged from 0 to 1.8 oocysts/100 L with a mean of 0.18 oocysts/100 L.[3]

Giardia lamblia and *Cryptosporidium* concentrations in SWP/Delta water were approximately six times lower than in surface water compared in nation-wide surveys (LeChevallier et al., 1991).